AIR ENGINEERING

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NOVEMBER, 1959

AIR POLLUTION CONTROL • AIR MOVING • AIR CONDITIONING

- *How Kaiser Cleans Air At Fontana Steel*
- *Process Cooling In A Capsule Factory*
- *Air Conditioned 'Phytotron' Room Grows 'Standard Plants'*
- *Techniques For Designing Efficient Air Distribution Systems*
- *Unique Air Conditioning System Sanitizes Hospital Air*

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3. AIR ENGINEERING reaches over 1,700 code enforcement authorities, industrial hygienists, medical researchers and industrial engineering departments . . . the men who are constantly working to improve atmospheric conditions.

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PUBLISHED MONTHLY
CIRCULATION GUARANTEED 10,000

B = BUYERS
S = SPECIFIERS
R = RECOMMENDING OR APPROVING

	ENGINEERS IN INDUSTRIAL PLANTS, BUILDINGS, INSTITUTIONS	CONSULTING ENGINEERS AND ARCHITECTS	FEDERAL, STATE AND MUNICIPAL AUTHORITIES	EQUIPMENT MANUFACTURERS AND THEIR SALES OUTLETS	MECHANICAL CONTRACTORS
FANS AND BLOWERS	B	S	R	B	B
AIR FILTERS	B	S	R	B	B
AIR CONDITIONING EQUIPMENT	B	S	R		B
VENTILATORS AND EXHAUSTERS	B	S	R		B
STOKERS, BURNERS, ETC.	B	S	R		B
STACKS, CHIMNEYS	B	S	R		B
ODOR NEUTRALIZERS	B	S	R		B
CATALYTIC PURIFIERS	B	S	R	B	B
INCINERATORS AND WASTE BURNERS	B	S	R		B
GERMICIDAL RADIATION	B	S	R	B	B
DUST COLLECTORS	B	S	R		B
AIR WASHERS AND SCRUBBERS	B	S	R		B
SOLVENT RECOVERY SYSTEMS	B	S	R		B
FUME COLLECTORS	B	S	R		B
CONTROLS	B	S	R	B	B
TEST APPARATUS		B	B	B	B
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. . . or wherever air treatment or air control problems exist

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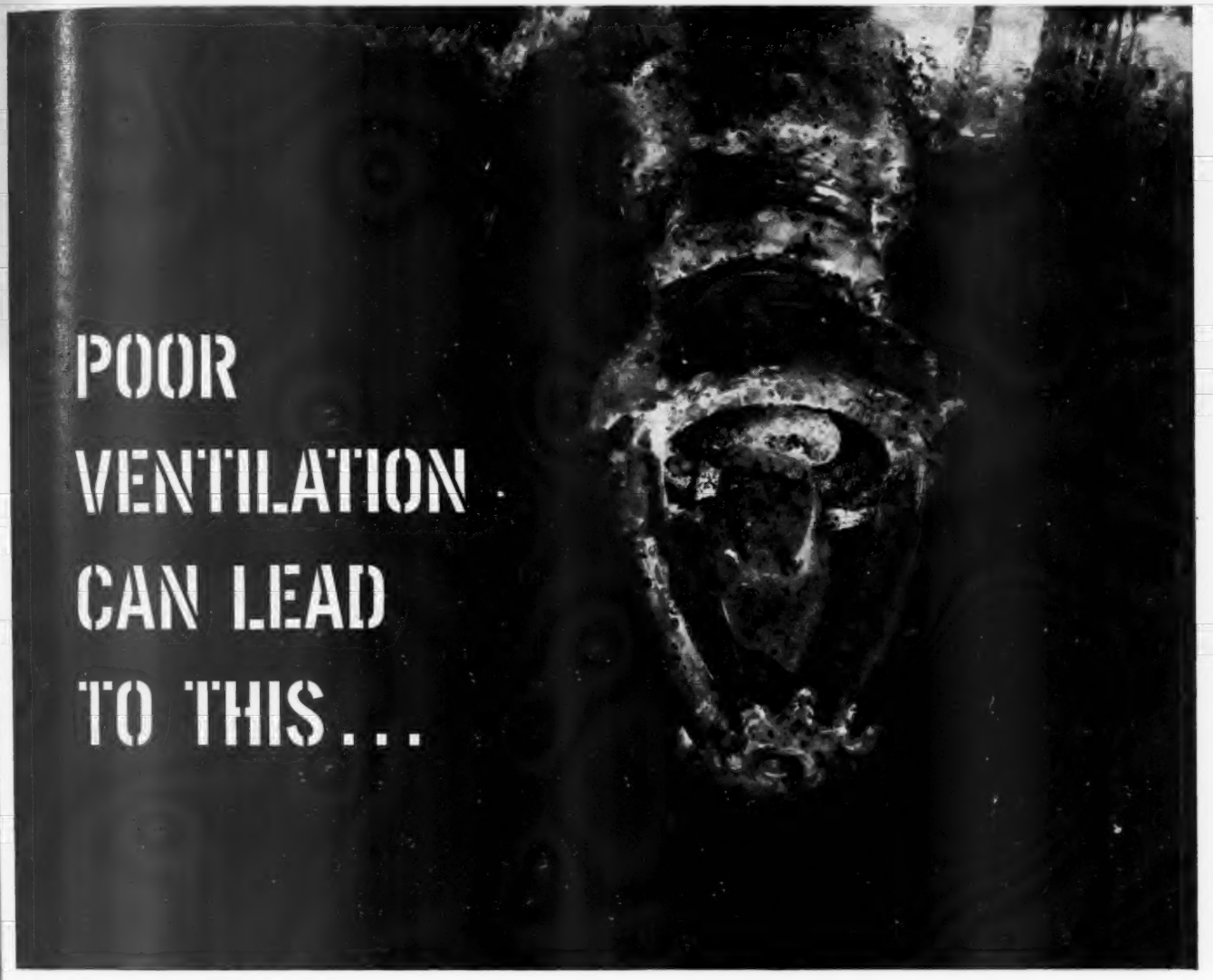


Hartzell ventilation can help prevent it

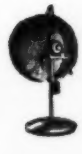
One plant which had been replacing corroded sprinkler system heads every two months now reports eight months without a change since a Hartzell fiberglass duct fan was installed to exhaust acid fumes from over a row of plating tanks. And that's a typical example of how a small investment in effective ventilation can produce tremendous savings on plant maintenance costs and on replacement of expensive fixtures and equipment. Even very mild concentrations of corrosive elements can cause extensive damage if you don't keep them under control.

There's no stock answer to the problem of controlling corrosive fumes, but effective ventilation is a part of every complete solution. Standard exhaust fans or roof ventilators may be adequate for one job . . . the next may require special equipment such as Hartzell's new all-fiberglass duct fans.

Whether you're concerned with the operation of an existing plant or the design of a new one, Hartzell has the fan or blower that's exactly right to help you keep corrosive fumes under control. Your nearby Hartzell representative will be happy to supply complete information and recommendations. If you don't know him, just drop us a line for his name and address or check the Hartzell catalog in Sweet's Plant Engineering or Industrial Construction File.

here's a complete line of air moving equipment designed and built specifically for industry

Other famous Hartzell products include controllable and full feathering propellers for light aircraft, crop drying equipment and farm ventilating fans.



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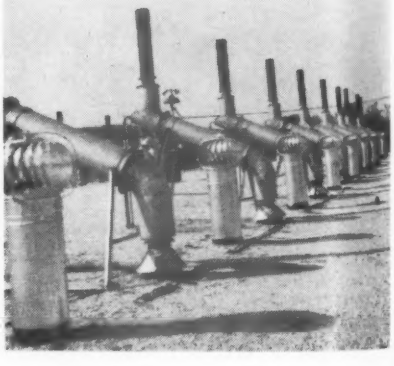
Letters

Comments on Caps

Editor:

I am in thorough accord with comments of A. G. Mutimer (registered engineer) as per his letter in the August issue of AIR ENGINEERING, in which he questions the use of caps on exhaust stacks.



The enclosed snapshots show the before and after appearance (from opposite ends) of a local wire making mill roof in this area, whose old upright natural draft smoke and odor incinerators were duly capped and wasteful of fuel gas.

Over 50 percent savings in fuel was realized by the change to the new Surchem design, more than enough to pay for the entire substitution inside of a year. In both pictures, the natural draft incinerators are in use. The operation is on a round-the-clock, seven-day-a-week schedule.

Hector Audino, B.S.
Consultant
Ridgefield, N. J.

(Please turn to page 4)

AIR ENGINEERING

VOL. 1, NO. 8 NOVEMBER, 1959

DEDICATED TO THE SCIENCE OF AIR POLLUTION CONTROL
AIR MOVING • AIR CONDITIONING

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COVER

The cover represents the artist's interpretation of a pouring operation in a foundry. Note the lateral exhaust vents at right of drawing. Artwork for the cover was supplied by courtesy of Cities Service Oil Company, Inc.

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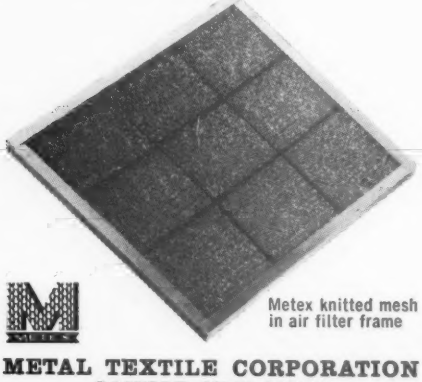
- COMMODITY AIR FILTER MESH
- FOG COALESCERS

Cutting knitted mesh for air filter



Metex knitted mesh in air filter frame

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Letters

(Continued from page 2)

On Turn-down Limitations

Editor:

In your September issue (Part II of Primer on Factory Ventilation, p. 26), one of the disadvantages listed on the use of gas as the fuel for make-up air systems was turn-down limitations. A few years ago, Maxon Premix Burner Company placed on the market a gas burner which they termed the Airflo Burner and which was designed specifically for heating air. The turn-down ratio is 25-to-1.

With this turn-down and the Maxon temperature rise of 70° the minimum temperature rise would be 2.8°. For factory make-up air applications, this is more than adequate control and certainly, you could not say this burner would have turn-down limitations.

Because this equipment has been on the market and has been installed in many plants in the last year, it is my belief that your readers should be made aware of some of the developments that the article overlooked.

Ludlow H. Kaeser
L. H. Kaeser Co.
Portland, Ore.

From the editor:

Our thanks to Mr. Kaeser for bringing this equipment to the attention of our readers. We urge all of our readers to write us directly, or use the convenient addressed cards in the Communications Center on page 33, to comment on any article in any issue of AIR ENGINEERING.

Editor:

We have enjoyed your articles very much. Please publish more articles on smoke control methods and application. Thanks.

John Crymes
Sales Engineer
AirFlo Heating and
Air Conditioning Co.
Richmond, Virginia

From the editor:

Mr. Crymes' request points up the editorial concept of AIR ENGINEERING *. . . that air engineers are as concerned with the* purity *of air as they are with the* control *of its temperature and humidity.*

Editor:

The information contained in the tear sheets "The Meaning of Clean Air" is now being evaluated by our Management, and will undoubtedly be of much value to the Bendix Aviation Corporation, Kansas City Division.

R. R. Griner
Construction Project Engineer
Bendix Aviation Corporation
Kansas City Division

High Temperature Fans

Editor:

The July issue of AIR ENGINEERING was loaned to me today and I was immediately attracted to the series on "High Temperature Fan Selection." I would appreciate having a set of tear sheets on this article when the series is completed. (This is) a fine publication.

Paul O. Kock
Consulting Engineer
Columbus, Ohio

Editor:

We have seen a recent issue of your excellent publication and find that it has many informative articles. We should appreciate your sending us the April and May 1959 issues and placing our name on your mailing list to receive all future issues.

W. H. Barkley
Staff Mechanical Engineer
General Electric Company
Schenectady, N. Y.

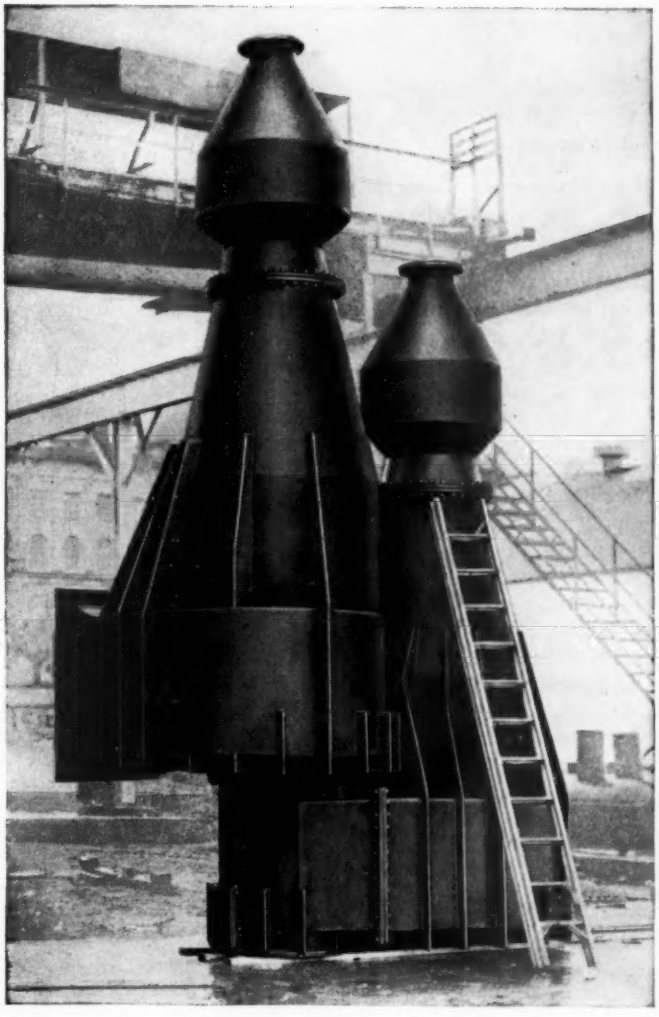
Editor:

This is to transmit to you our belated thanks for the notice you gave our course in Air Pollution (see inside back cover, Sept. issue). We are immensely grateful for the very fine display and encouragement given to this program.

Norton Nelson
Professor and Chairman
New York University
Institute of Industrial Medicine

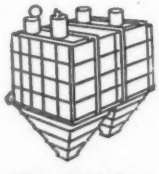
(Please turn to page 6)

Use Communications Center, page 33, for requesting more information about articles, advertised products, literature, etc.

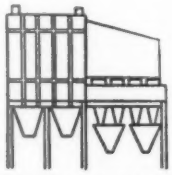


Exploring new frontiers!

BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS



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But these aren't satellite launchers, though they're specially designed for high temperature operation: they're Buell extra-efficient cyclone dust collectors . . . and the new frontiers they're exploring are in industry. Everywhere in American industry, from cement mills to refineries, from chemical plants to power generating stations, Buell collectors set new records in percentage of dust removed, low maintenance, and improved plant operation. Even in the age-old field of fly ash collection, Buell extra efficiency pays off. Only *Buell* cyclones have the unique Shave-off port that traps small fines in the double eddy currents. And Buell large-diameter design eliminates bridging, clogging, or plugging. *All three* Buell Systems are illustrated and described in "The Collection and Recovery of Industrial Dusts". Write for a copy to Dept. 62-K, Buell Engineering Company, Inc., 123 William St., New York 38, N. Y.

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Letters

(Continued from page 4)

Issues Challenge on Caps

Editor:

If people (see letter from L. Flickinger, Vice-president of production, Zippo Manufacturing Co., on page four, Sept. issue) are seriously concerned about possibility of rain entering fans, it is a simple matter to place drain holes in bottom of fan housings. Then, water runs out on roof. If fans are inside then we run small drain pipes from these holes to some point of drainage in the building.

Of course, proper lapping of joints of exhaust ducts to insure any droplets reaching fan housings is important. I can point to dozens of fans in operation for years, inside and outside of buildings, without housing drains and there have been no complaints about water. Any water which ran down into housing when fans were not running rapidly evaporated when fans started to run.

Above considerations are necessary only when fans are inside. In Zippo's case, fans are on roof, so at most only consideration is the making of holes in bottom of fan housings.

Now as to snow, the comment about snow plugging fans is common. Actual experience indicates that this just doesn't happen. Amount of snow which may fall into fans through stacks is small in relations to the areas of fan housings. We have never seen it enough to fill housings so that it reaches wheels. When fans are not running, warm air from heated factory below due to stack effect, moves by gravity out through fan stacks. This warm air also melts snow.

Of course, I am recommending removal of caps only, not removal of stacks. To me, stacks on fan outlets are very desirable and, of course, they should be vertically up from upblast discharge fans. Normally we evase (enlarge gradually) the stacks when recovery of velocity pressure is a factor. These evases should increase the tendency for rain and snow to enter stacks, but this has never been a problem.

There is the added advantage of no caps on exhaust fan stacks like Zippo's from a noise angle. Caps definitely tend to turn noise down. In fact, we have licked a number of definite fan noise problems just by removing caps.

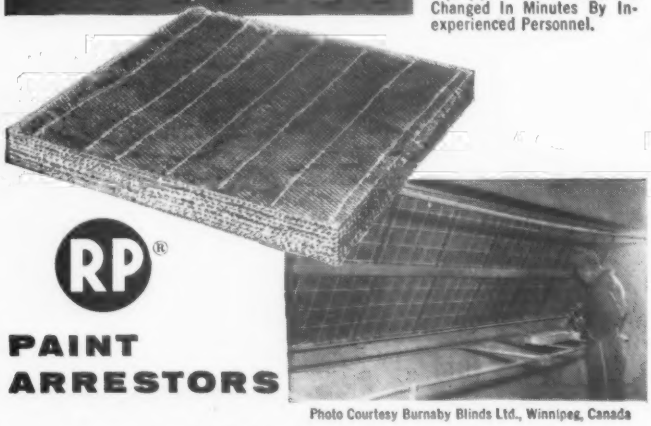
I guess this is a lot of discussion regarding caps on exhaust stacks like those shown at Zippo. (See bottom of page 47, July issue). However, if I were to enter into a wager with Mr. Flickinger, he to send me a bottle of Scotch for every year he would operate with capless stacks with no trouble and I to send him same for each occasion when he experienced system troubles due to uncapped stacks, I feel certain that any liquor shipments would be from Zippo.

A. G. Mutimer
Registered Engineer
Mutimer Company
Jenkintown, Pa.

FICTION and FACT

FICTION: Paint Overspray Control Requires Complicated and Expensive Maintenance Procedure.

FACT: An RP Paint Arrestor Equipped Booth Can Be Changed In Minutes By Inexperienced Personnel.



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PAINT ARRESTORS

Photo Courtesy Burnaby Blinds Ltd., Winnipeg, Canada

Inexpensive R P Paint Arrestors are easily replaced in a short time to provide like-new paint overspray removal efficiency, with minimum down-time, at a fraction of usual maintenance costs. Economical original installation, too—and adaptable to almost every type operation, R P Paint Arrestors can cut costs, increase production in your booths, too. Write for information.

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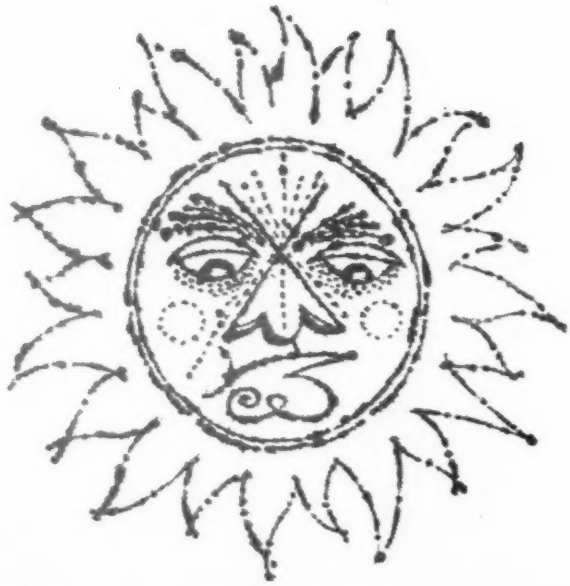
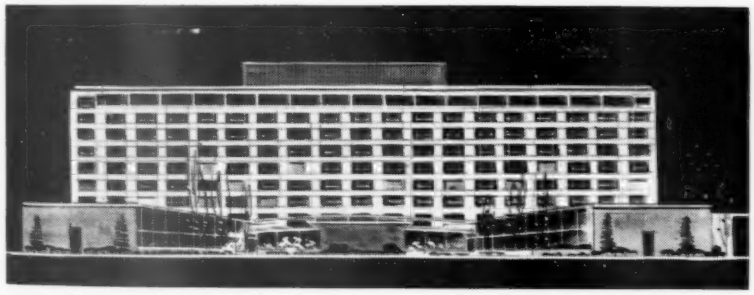
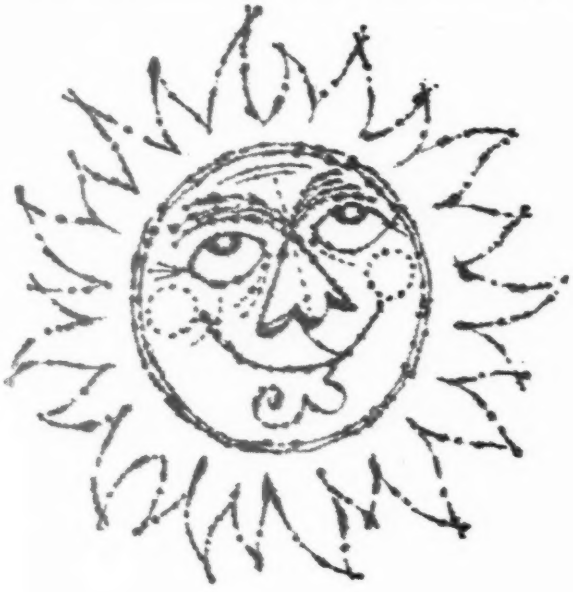




SHERATON-PORTLAND HOTEL, PORTLAND, ORE. Architect: Church, Newberry, Roehr & Schutte; Consulting Engineer: J. Donald Kroeker & Associates; Mechanical Contractor: J. M. Harder Plumbing & Heating Company.



Climate by Chrysler

Pumps out heat in summer, pumps in heat in winter . . . saves money all year for new Sheraton Hotel

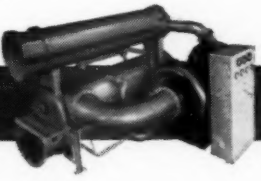
The most complete heat pump system ever installed in a hotel is providing a money-saving answer to the problem of all-year air conditioning for the new Sheraton-Portland, in Portland, Oregon.

The system takes advantage of low local power rates and utilizes available well water. In summer, two 250-hp Chrysler Centrifugal Heat Pumps use the water to absorb heat from indoor air and keep the hotel cool. In winter, the cycle is reversed. Heat is extracted from the water and pumped into the hotel.

Individual Chrysler fan-coil units give occupants of each room complete control over indoor climate. Public spaces are served by Chrysler central air-handling units.

The Chrysler Heat Pump is versatile: It also supplies domestic hot water for the hotel's 300 rooms, and delivers, through boosters, near-boiling water for the kitchen. And the system is economical: It costs less to operate than conventional year-round air conditioning . . . and it even warms the swimming pool without added cost.

Whether your air conditioning requirements are best met by a heat pump or conventional air conditioning, Chrysler has the equipment and technical know-how to help you do the job better . . . for less. For information on the mechanics or economics of Chrysler equipment, write today.



CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. AA-119, Dayton 1, Ohio
In Canada: Therm-O-Rite Products, Ltd., Toronto, Ontario

New Appointments

Dave Ross has been appointed permanent chairman of the Lorain, Ohio smoke abatement committee. **Bill Trace** was elected secretary.

Albert O'B Andrews has been appointed president of the American - Standard Industrial Div. which is headquartered in Detroit, it was announced by Joseph A. Grazier, president of the corporation.

A. Andrews

Andrews succeeds **John W. Brennan,** who will engage in the engineering and development of the corporation's air conditioning and related product lines, with particular emphasis on expansion in overseas markets.

Prior to his new appointment, Andrews was vice president and controller of the Industrial Div. He has been associated with American-Standard since 1950.

Appointment of **William F. Peters** as general sales manager is announced by Anemostat Corp. of America. Peters rejoins Anemostat after serving as New York branch manager for the American Air Filter Co.

W. F. Peters

Prior to his association with American Air Filter, Peters held various positions with Anemostat since first joining the company in 1945 as a research engineer. He was appointed eastern regional sales manager in 1949 and assistant general sales manager in 1956. He joined American Air Filter in 1958.

H. W. Rainey, Jr. has been appointed general sales manager of the Sturtevant Div., Westinghouse Electric Corp. Before his appointment, Rainey had been field sales manager for three years.

Rainey, Jr.

Sturtevant also announced the appointment of **Marion J. Kolasa** as Detroit district manager. Kolasa joined Westinghouse in 1953 as sales and application engineer. He will be responsible for Sturtevant sales in Michigan and parts of Ohio.

A. J. Draves became a partner of Parry Engineering Co., New York City, representative for manufacturers of dust control and other power plant industrial equipment.

Robert B. Alexander has been appointed sales manager at Elgen Mfg. Corp., Long Island City, N. Y. Elgen manufactures flexible duct connectors, louver and vane runners, duct tapes, and other products for air conditioning, heating, and ventilating.

R. Alexander

Alexander will work with Louis Josephson, president, in calling on representatives and jobbers throughout the United States and Canada. He was formerly with Youngstown Div., American-Standard and Sanitary Radiator Corp.

A. P. Equipment Co., St. Louis, has been appointed as representative for Stoddard Industries of Cudahy, Wis., in the sale of Dust-magnet electrostatic air filters in St. Louis and the surrounding territory.

T. Coon

Ted Coon, general manager of A. P. Equipment Co., has had wide experience in the air movement field, having been with Worthington Corp. and the York Corp.

William E. Hoctor has joined the Westinghouse Electric Corp.'s Air Conditioning Div. as manager of manufacturing.

Hoctor was formerly associated with the motor and control division of Westinghouse at Buffalo, where he was general foreman. In his new position, he succeeds **Burr Tupper,** who has become director of works engineering at Westinghouse headquarters in Pittsburgh.

Appointments of **W. Donald Geiser** as production manager,

W. D. Geiser

G. E. Klein

George E. Klein as assistant production manager, and **Thomas F. Facius** as chief engineer of Baltimore Air Coil Co., Inc. is announced by John Engalitcheff, Jr., president.

T. F. Facius

Geiser has been chief design engineer for the past two years and before that was a development engineer with York Div., Borg-Warner Corp.

Klein has been in BAC's production department since 1953 and has held posts as purchasing agent, traffic manager, and production coordinator.

Facius has been a research engineer since 1955. Before that he was with York Corp. for a year.

Ralph S. Penn, president of Penn Controls, Inc., has announced the appointment of **H. M. Carnahan** and **George S. Myers** to new posts of vice presidents.

H. Carnahan

Carnahan is now vice president-director of sales for the control firm. He first joined Penn in 1957 as director of sales, being responsible for all Penn sales activities, both foreign and domestic. Myers, now vice president - director of manufacturing, joined Penn in 1954 as director of manufacturing. He came to Penn from the Perfect Circle Corp. where he held the position of works manager.

G. S. Myers

Health, Air Pollution and Climate Study Underway in New York

A one-year exploratory study of the relationship between climate, air pollution, illness, and mortality in New York City is being conducted jointly by that city's department of Air Pollution Control and the Department of Health, under a $41,540 grant from the U.S. Public Health Service.

Investigations will be made of the possible association between the frequency of human deaths from external and other causes and variations in air climatologic conditions and air pollution. Frequency of homicides, suicides, and accidental deaths will be compared with climatic conditions preceding such fatal episodes. Possible effects of abrupt climatological changes or peaks in air pollution in precipitating deaths in persons affected with severe cardiac or pulmonary ailments, will be studied.

Study will be under the guidance of Dr. Leonard Greenburg, Commissioner of Air Pollution, and others in that department and in the N.Y.C. Health Department.

No Action Yet On Fast Write-Offs For Air Cleaning Equipment

Congress has taken no action as yet on any of the proposed legislation which would permit rapid tax write-off, rapid amortization of other financial relief for certain types of air cleaning equipment. Congressional Bill HR 7566, for example, is still under consideration. This particular bill has the support of the San Francisco Bay Area Air Pollution Control Department. Coming later, an analysis of this legislation.

Swartwout Sells Ventilation Division to Kokomo Manufacturing Co.

The 54-year-old Swartwout Co., Cleveland, is reported to have sold its industrial and commercial ventilation equipment division to Kokomo Manufacturing Co., Kokomo, Ind.

While manufacturing equipment will be moved to Kokomo, the division will retain its identity as Swartwout Fabricators, Inc., Kokomo. President will be G. B. Patterson, sales and advertising manager will be Robert Parshall.

Industry Complains New A.E.C. Radiation Safety Standards Too Strict

Exposure standards recommended by the National Committee on Radiation Protection and proposed by the A.E.C., are designed to set new safety standards for workers involved with radiation.

The A.E.C. proposes adoption of new standards, which would drastically reduce the radiation exposures permitted for atomic workers, and require strict records of all such exposures. (See page 40, this issue, for an outline of the new exposure standards).

Main objection of industrial firms is that the new standards would impose economic hardships impeding development and use of atomic energy. New standards cut by one-third the present permitted exposures, from 15 to 5 rems per year. Maximum exposure in any one year would be held to 12 rems, for any worker beyond 18 years of age.

Labor unions, on the other hand, think the proposed safety radiation exposure program not strict enough, according to a report in the *New York Times*.

Russian Air Cleaning Engineering Manual Published in U.S. Translation

A Russian book on industrial air pollution treatment from an engineering standpoint has been published by the office of technical services, U.S. Department of Commerce.

Written by V. N. Uzhov of the technological division of Institute for Making Gas Purifying Equipment, Moscow, it was translated by Dr. B. S. Levine under a U.S.P.H.S. grant. The book is said to be a full treatment of Russian developments in the field of air cleaning.

Proposed Regulations by San Francisco Could Cut Particulates 73 Percent

Benjamin Linsky, Air Pollution Control Officer of the San Francisco Bay Area Air Pollution Control District, stated that a proposed new Regulation No. 2 could cut total particulate emitted to the San Francisco area atmosphere by about 73 percent, and would reduce organic gases about 20 percent.

Proposed Regulation 2 would affect operations which produce dusts, droplets, and combustion gases, particularly industrial processes, incineration, heat transfer, general combustion, materials handling and heating, and power plants. Control will be based on grain loading, process weight, Ringelmann scale, particle size, volume in ppm, and energy content of fuels burned.

Universal Match Buys American Air Curtain

Universal Match Corp., St. Louis, has announced purchase of American Air Curtain Corp. The latter firm manufactures and installs air circulating systems creating hermetically sealed curtains of air, replacing conventional doors. New acquisition will be operated as a wholly owned subsidiary. "Air curtains" have been installed on Post Office loading platforms and are finding use in entrance-ways to permit people passage while barring loss of conditioned air and serving as a barrier to insects, dust, and dirt, according to Ernest Gygax, founder of American Air Curtain and vice president of the new subsidiary.

Research on Relationship of Agriculture to Air Pollution

An intensive research program is now in progress at the University of California to determine facts on the relationship of agriculture to air pollution, specifically agriculture's contribution, resultant damage, and possible alternatives to burning of waste materials. Factual data may be available in about one year, according to John J. McElroy, program leader for special projects at the University's Agricultural Extension Service at Berkeley.

Smoking Just Another Form of Air Pollution

Ronald V. Christie, physician-in-chief, Royal Victoria Hospital, Montreal, and chairman of the Department of Medicine, McGill University, said: "The relationship of chronic bronchitis to cigarette smoking, which after all is just another form of atmospheric pollution, has (also) been clearly established."

Survey in a large plant employing almost 2000 workers, he went on, revealed that incidence of chronic bronchitis in one group of 560 non-smokers rose steadily until at age 50 or 60, 15 to 16 percent suffer from chronic cough. In another group of moderate smokers the incidence in the same age group was up to 30 or 35 percent and in the group of heavy smokers, the incidence in the same age group was over 40 percent.

Concluded Dr. Christie: "There is no doubt that the air we breathe is the principal factor which governs the incidence of chronic bronchitis and its results." In Canada, he stated, chronic bronchitis and emphysema is the third commonest cause of death, being led only by heart disease and lung neoplasms.

AIR ENGINEERING

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EDITORIAL:

Needed: Cleaner Communication Among Clean-Air Specialists

COMMUNICATING HAS become the most confused – yet possibly most important – problem in American business today. Especially is this true of a complex field like *air engineering*, which is in need of faster development.

Because this newly identified science involves both contaminant control and air conditioning *within* and *around* big buildings where people work, it is vital to human survival.

That's why it needs simplification and clarification, rather than obfuscation. If it is to gain public support, ordinary citizens will need to understand what it is all about.

Yet, specialization of business endeavor breeds cryptic languages, odd vocabularies, and "what did he say?" jargons. Birds of a feather tend to flock together and to exclude specialists in other fields from their conversations. Hence they become more and more unintelligible to the layman.

Obviously this phenomenon is occurring in the tribal conclaves of industrial air handling and purification experts.

Dialects of merchandising, engineering, and management have tended and trended to become as different and mutually incomprehensible as Latin, Sanskrit, and cool teen-age lingo. Unfortunately this language-fractionization *impedes progress*, especially in a relatively new, necessarily engineer-dominated industry.

Engineers deal with tangibles. Their knowledge involves certainties. In their world they can *prove* what's what and how. That's why they often feel superior to non-engineer types like sales and public relations personnel. The latter, some engineers are apt to feel instinctively, aren't "with it."

In his new book, "The House of Intellect," Columbia University's Jacques Barzun accuses specialists of retiring into inarticulate confusion as a release from responsibility. "They talk pompous jargon and affect a methodology that's suspect and withdrawn from the actual world."

Scientists, especially those in the relatively new and complex *air engineering* field, have an urgent

(Please turn to following page)

NEWS of the Industry

Midland-Ross Buys Surface Combustion

Midland-Ross Corp. of Cleveland recently purchased Surface Combustion Corp. of Toledo, Ohio for a reported $23 million.

Surface Combustion will continue to operate as a division of Midland-Ross. No changes in policies or management is contemplated, according to Wade N. Harris, president of Midland-Ross, and Henry M. Heyn, president of Surface Combustion.

Surface Combustion Corp. produces industrial and residential heating and air conditioning equipment, and heat treating equipment. Midland Ross produces automobile frames, power brakes, and engineered atmosphere control equipment.

Medics Review Hospital Air Sanitation and Air Conditioning

At the 108th Annual Meeting of the American Medical Association, held recently in Atlantic City, staphylococcal disease (in hospitals) received more attention than any other infectious disease. There were five scientific exhibits, three scientic papers, one chairman's address, three films (including a first showing of a new AMA film), and one color TV panel discussion on the subject.

In Atlanta, the Communicable Disease Center of the Public Health Service, under Dr. S. W. Simmons, Chief of the Technology Branch, is setting up a large scale study of hospital construction and air conditioning in relation to contamination of the hospital environment. Dr. Simmons is assembling a staff of physicists, microbiologists, ventilation engineers, and others to assist in this research.

In Boston, at Boston City Hospital, Dr. Maxwell Finland, favored tight control of antibiotics, says that since staph infections problems were first realized, "routine prophylactic use of antibiotics has dropped to 15-20 percent of former usage. Dr. Finland referred to work being done on epidemiology of hospital infections by Dr. Heinz Eichenwald, at New York Hospital. He thinks that Dr. Eichenwald has demonstrated that certain patients expel "clouds" of staphylococci.

Editorial *(Cont.)*

Need for Cleaner Communications for Clean Air

(Continued from preceding page)

responsibility to make themselves understood. They should avoid that natural tendency to build a new dictionary around their specialty.

Thus we commend the so-called San Francisco Approach to "engineered air" terminology – definitions which can be understood by engineer, salesman, and layman alike – without confusion, disagreement, or misunderstanding.

Ben Linsky (who pioneered "clean air" in Detroit and San Francisco) and S. I. Hayakawa (renowned educator and expert in semantics) have collaborated on a glossary which equipment producers, salesmen, and researchers ALL can employ to gain clarity and – with mutual profit – to achieve communicational progress.

"Impure air," they say, includes the following effects:

1. Visibility interference.
2. Sky darkening.
3. Soiling of surfaces, light or dark.
4. Annoyance to senses.
5. Damage to vegetation.
6. Other property damage.
7. Interference with production or services.
8. Impairment of health.

The effects of impure air Messrs. Linsky and Hayakawa stash into two further groupings:

(a) Localized effects, from a single source or group of sources, on nearby areas.

(b) Area-wide effects, extending more than a mile or two from a point of origin.

The physical nature of air pollutants they break down into the following five categories:

1. Granular dust.
2. Microscopic dust.
3. Visible droplets.
4. Microscopic droplets.
5. Gases.

This is a fair start toward an intelligible vocabulary for *air engineering* – although it doesn't embrace much in the way of air conditioning (which controls indoor pollutants) terminology.

No matter how intrinsically important it may be, a new science won't get off the ground unless salesmen and buyers understand it and know what it can do for them. They have to grasp what the *engineers* are talking and writing about before they'll grab for the benefit.

Of this we can be sure: translators and communicators will command higher and higher premiums in subsequent years. And the responsible business press will become more and more useful.

That's where *we* come in (AIR ENGINEERING Monthly). Our job is interpretation, education, and the advancement of business cooperation. How? By publishing easily-understood information about all phases of this industry's variegated activities.

The key word to acceptance and success is UNDERSTANDING.

whereas others harbor the organism but do not heavily contaminate their environment.

And, according to California Department of Health, among other areas much basic research needs to be done in the role of environmental sanitation.

Four new educational aids on staph in hospitals have been released: 1. *Hospital Sepsis,* a Johnson and Johnson film, available from that firm; 2. *Epidemiology of Staphylococcal Infections,* a filmstrip with magnetic tape recording, available from Communicable Disease Center, U.S.P.H.S.; 3. *Control of Staphylococcal Infections in Hospitals,* a pamphlet available from the New York State Department of Health, Health Education Service, P.O. Box 7283, Albany, N. Y. at 50 cents per copy, reduced cost in quantity; 4. *Selected Materials on Environmental Aspects of Staphylococcal Disease,* Public Health Service Publication No. 846, available from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., at $1.50 per copy.

For valuable information on control of air borne bacteria in the hospital environment, see the article in this issue, "Low Cost Solution to Hospital Air Sanitation" beginning on page 18.

S.O.S. Grows to 62,000 Strong

Marking its first anniversary last month, members of SOS—The Women's Organization to Stamp Out Smog—now claims to number 62,000 members, most of them residing in California. At its meeting a decision was made to urge California mayors to request a special smog session of the California legislature early next year.

Mayors will also be asked to include the following points toward elimination of smog in their cities:

1. To strive for a coordinated program of air pollution research between private and governmental agencies and to establish regional air pollution control districts.

2. To obtain adequate rapid transit systems, enforcement of a standard of maximum exhaust emission, effective smog control legislation, extensive automobile inspection, and to work for recomposition of gasoline in order that products of combustion injurious to health are held to a minimum.

Cleaner Air Week Outstanding Success

Cleaner Air Week (see page 8, August issue), held Oct. 25 to 31, was an outstanding success, according to Charles N. Howison, National Chairman of this Air Pollution Control Association Committee.

Howison stated that 25 to 33 percent more cities participated in Cleaner Air Week than during any other of the eleven previous such weeks held annually in the past.

He said that such tremendous support on the part of both large and small cities, industry, and private citizens, indicates an increased awareness of the problem of air pollution nationally.

Besides having direct support of the President, the Cabinet, and Congress, Howison said that Governors of 27 out of the 50 States gave specific proclamations about Cleaner Air Week.

Project Airlift, in which balloons decorated with an air pollution theme where released at public events such as football games, was also an outstanding success. Balloons were to demonstrate how air pollution travels and spreads over a community. Balloons carried cards to be returned to Howison by the finder. Forty such cards were returned; one card, borne by a balloon released in Chicago, was found 36 hours later in Boston Harbor by the captain of a Finnish freighter and mailed back to Howison in Cincinnati.

Paper Mill Awards Air Cleaning Contract

Contract to furnish a double-chamber electrostatic precipitator for the Tennessee River Pulp & Paper Co. plant near Corinth, Miss., has been awarded to The Metal Products Div. of Koppers Co., Inc.

Specifications provided by the M. W. Kellogg Co., consulting engineers who purchased the unit for the paper company, call for it to handle 125,000 cfm of gas generated in a kraft recovery furnace and to remove 97.5 percent of particulate matter from the gas stream.

In addition to prevention of air pollution, use of electrostatic precipitators on waste gases in kraft paper mills makes possible recovery for re-use of a high percentage of the salt cake used in the "digesting" of pulpwood for processing into paper.

Award of the Corinth contract brings to 57 the number of Koppers precipitators in use in that field. The St. Regis Paper Co. is the largest user of Koppers units of this type, with 11 installations in four plants, while International Paper is next with eight units at four plants.

Julian Nardi Killed In Virginia Plane Crash

Julian Nardi, chief mechanical engineer of Ford, Bacon & Davis, Inc., New York engineering and management consultants, was among the 26 persons who died in Piedmont Airlines plane crash Oct. 30 in Virginia. Nardi, who was 62, had been with the New York firm 24 years, and had worked on the design of many major industrial projects.

Underground Computer Plant Studied

Buffalo Forge Co. has announced that it will participate in a study this fall and winter to be conducted by Cornell University to determine the feasibility of building an underground computer plant for International Business Machines Corp.

At the same time the firm disclosed that it has increased sales of its specially designed ventilators for large as well as family-type bomb shelters.

The I.B.M. plant study will explore various measures by means of which a critical industry might insure survival of employes and continued operation in the event of attack by an enemy using nuclear, biological, or chemical warfare weapons.

Placing an industry underground, either by boring into the side of a mountain, or scooping out a large hole and covering it with soil, is one of the defensive measures to be considered.

Buffalo Forge's role in this project will be to supply technical information on standards for the ventilation, air conditioning, and air filtering for the underground plant.

(Please turn to following page)

NEWS of the Industry . . .

(Continued from preceding page)

Western Precipitation To Be Div. of Joy Mfg.

Shareholders of Western Precipitation Corp. of Los Angeles have approved the acquisition of the assets of Western by Joy Mfg. Co., Pittsburgh.

Western is a leading supplier of electrical precipitator, filter, wet scrubber and mechanical types of dust collecting equipment; and also heat-exchange equipment for material processing. Joy, world's largest producer of underground mining equipment, also makes wet inertial dust collectors and a variety of industrial products.

Western Precipitation will be operated under that name as a division of Joy.

Certification Program Set for Heat Pumps

A certification program for unitary heat pump air conditioners will be inaugurated by the Air-Conditioning & Refrigeration Institute to parallel the now operative certification program for unitary air conditioners.

The heat pump certification program will be based on testing and rating in accordance with ARI Standard 240, which the Unitary Section will revise in order to bring up to date its references to Standards of ASE, Underwriters' Laboratories, and particularly to the proposed new ASHRAE Standard Methods of Testing for Rating Heat Pumps.

New Yorkers Complain At Record Rate

During the first nine months of 1959 more complaints on violations of air pollution regulations were received by the New York City Department of Air Pollution than during any similar period since the city agency was formed seven years ago.

The number of complaints filed by city residents totaled 13,456 during the last nine months. In 1958, during the same period, there were 10,679 complaints.

Also in New York City, the Consolidated Edison Co. has started a $5 million program for the control of air pollution in the three power plants it bought from the city on Aug. 1.

The reduction of air pollution will be made progressively in the three plants over the next year and a half. It will be done by building high-pressure boilers with complete equipment for the control of air pollution, the abandonment of some obsolescent coal-fire low-pressure boilers that cause smoke and fly-ash emissions, and the conversion of others to oil.

TV Radiation Won't Hurt Viewers' Gonads

A research report in the Oct. 23 issue of Science, page 1074, concludes that the possibility of radiation damage to gonads of viewer, from television receivers, is extremely remote. The report states that: "From a genetic point of view, a permissible radiation level of 0.5 mr/hr at 5 cm from any accessible surface of the equipment appears reasonable and will not require any changes in most existing sets. Even if all sets emitted radiation at this rate the contribution to the gonad dose at usual viewing distances would still be less than 5 percent of that due to average natural background."

Steel Mill Updates Ventilation System

Part of the modernization program at the Campbell Works of Youngstown Sheet and Tube Co. involves the installation of Sturtevant Div. of Westinghouse fans and filter equipment to force ventilate 12 main-stand motors and two large motor-generator sets.

The original updraft ventilating system at the plant's 79-in. hot strip mill is being changed to a downdraft noncirculating system. However, it will be possible to recirculate the warm air from the machines back to the motor room during winter operation.

Three 20-ft. bays of roof area will be redesigned to house the supply air system. Twelve vertically mounted vaneaxial fans will draw 825,000 cfm of air through filters and deliver it to the main motor room area. In the basement, seven Westinghouse Airfoil centrifugal fans will draw approximately 630,000 cfm through the motors and generators. Three Tubeaxial and four Airfoil centrifugal fans also located in the basement, will then exhaust this air to the atmosphere.

The system is said to be unique in that the amount of air forced through the machines will be considerably in excess of that generally used, thus enabling the mill to operate at higher loads without exceeding the hot spot temperature limits of large rotating apparatus.

Home Cooling Mfrs. To Push 'Pure' Air

Manufacturers of residential air conditioning will place a lot of emphasis on "clean" and "pure" air as one of the benefits of installing a central residential air conditioning system in the home, as a major part of their 1960 sales promotion plans.

"Live in an Air of Satisfaction" will be a major theme in all of the promotion of General Electric's Home Heating and Air Conditioning Department. At a recent distributor convention, J. J. Heffernan, manager of advertising and sales promotion for the department, declared that vast and growing numbers of people are discontented with the air in which they live, but that the industry hasn't exploited this discontent properly.

Airtemp Div., Chrysler Corp., also plans to emphasize the "clean air" function of air conditioning in both its residential and commercial line promotion. In a new year-round residential unit, it will offer an electrostatic filter, a charcoal filter, and a sterile lamp as accessories.

Other manufacturers are said to be spotlighting air purification in their 1960 programs.

2 Day Co. Affiliates Become Wholly Owned

Two affiliated companies of The Day Co., Minneapolis, are now wholly owned subsidiaries of the parent company. They are Day-com, Inc., and The Day Co. of Canada, Ltd. Both companies were brought under full ownership through an exchange of stock.

Day is a principal manufacturer of a complete line of industrial dust control, bulk storage, and bulk material pneumatic conveying equipment. A. B. Osgood, president, said current sales are running the highest in history.

Pollution Complaint$

Where there's a pollution problem there's a market for equipment to solve that problem . . . dust collectors, scrubbers, precipitators, blowers, other equipment.

Each month we plan to summarize air pollution situations in cities across the land as a service to equipment manufacturers.

We also plan to follow-up directly with each company involved to cover the solution to their problem as a service to our readers.

Sarasota, Fla.—An asphalt plant operated by Dunn Construction Co. of Birmingham, Ala. is said to emit smoke, dust, and noise in a charge by Sarasota County commissioners and the County building department.

• • •

Cleveland—The American Agriculture & Chemical Co., 4600 W. 140th St., named by area residents as source of ammonia seepage, causing spotting of aluminum siding, white dust on furniture, respiratory distress, damage to paint on cars. Thomas Bailey, the firm's superintendent, claimed seepage is negligible, states firm spent "tremendous amount to remove contaminants."

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Passaic, N. J.—Tidewater Iron and Steel Co., Inc., 333 River Drive, ordered by New Jersey State Department of Health, to cease violation of open burning provisions of New Jersey Air Pollution Control Code. Deadline for compliance, Jan. 1, with progress report by Dec. 1, 1959. Firm burns auto bodies and other materials for salvage.

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Houston — Standard Dredging Co., ending odor nuisance by putting neutralizing chemicals into water. Chemicals are said to combine with hydrogen sulfide to form new non-odorous compound.

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Toledo, Ohio—Central Rubber & Steel Co. was subject of protest by area residents to city Council. The charge, soot, and dirt emission covering autos, houses, and children. City solicitor Russel Rakestraw informed city Council that city has no smoke abatement ordinance covering the situation, stated petitioners would have to seek court injunction.

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North Little Rock, Ark. — This city's asphalt plant is under attack by area residents. The claim, plant emits dust. Plant is relatively new, being built in 1956, but no provision for dust control was installed when plant went up. Cost for dust control equipment is estimated to be about $10,000.

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Lewiston, Idaho—Requested, by this city's Air Pollution Committee, a study of air pollution, by the U.S.P.H.S. Committee met recently to discuss gathering of further data for S. Thatcher Hubbard, M.D., heart and lung specialist of Spokane, who is applying to the U.S.P.H.S. for a grant to study air pollution in the Lewiston-Clarkston valley.

• • •

Queens, N.Y.C., N.Y.—Plant of Eisenberg & Sons under fire by area residents. The complaints, excessive dustfall on the area, from the firm's rag processing operations. Plant is located at 65 Traffic St., near Palmetto St., Ridgewood. Respiratory distress has been reported by area residents.

Rocky Ford, Colo.—The Frank Hough bean cleaning plant has been the subject of complaints by merchants and residents. Dust from operations has been claimed to cause "great discomfort, health menace, serious damage to food, costly cleaning." Legal action is contemplated, after decision is made whether plant is a public or a private nuisance.

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Louisville, Ky.—Harold's Auto Parts, Lees Lane, fined by Criminal Court on charges of pollution by area residents. Partners of firm fined $1,000 each, sentenced to 90 days in jail. Site owner was fined $5,000. All three were put on five years' probation. Charges were appealed, but further suit is in the offing, by city-county Air Pollution Control Commission. Open trash burning is said to be source of pollution.

• • •

Johannesburg, South Africa — According to the South African Research Council for Scientific and Industrial Research, some 200 tons of sulphur dioxide, 30 tons of smoke, and 20 tons of gasoline vapor pollute the air over Johannesburg daily.

Dr. E. C. Halliday, head of the council's division of general physics, called for air pollution control legislation.

Meetings, Courses, Expositions

U. S. Public Health Service seminar on "Air Monitoring and Sampling Networks," *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 23-24.*

27th Exposition of Chemical Industries, *Coliseum, New York City, Nov. 30-Dec. 4.*

Three day conference on "Man and His Environment: The Air He Breathes," *University of California School of Medicine, San Francisco, Jan. 16-18, 1960.*

11th Plant Maintenance and Engineering Conference and Show, *Convention Hall, Philadelphia, Jan. 25-28, 1960.*

2nd Southwest Heating and Air Conditioning Exposition, *Memorial Auditorium, Dallas, Texas, Feb. 1-4, 1960.*

American Chemical Society, 137th national meeting, *Cleveland, April 5-14, 1960.*

Western Air Conditioning Industries Association, Third Western Air Conditioning, Heating, Ventilating, and Refrigeration Exhibit and Conference, *Shrine Exposition Hall, Los Angeles, April 27-30, 1960.*

Industrial Heating Equipment Association, Inc., *The Homestead, Hot Springs, Va., May 22-25, 1960.*

Institute of Boiler and Radiator Manufacturers annual meeting, *Seaview Country Club, Absecon, N. J., Week of June 6, 1960.*

American Society of Heating, Refrigerating & Air-Conditioning Engineers annual meeting, *Royal York hotel, Vancouver, B.C., Can., June 13-15, 1960.*

13th International Congress on Occupational Health. *Waldorf-Astoria hotel, New York City, July 25-29, 1960.*

Institute of Boiler & Radiator Manufacturers semi-annual meeting, *Seaview Country Club, Absecon, N. J., Week of Oct. 31, 1960.*

Industrial Building Exposition and Congress, *Coliseum, New York City, Dec. 12-15, 1960.*

New Literature

Heating Handbook Reappears

The Dunham-Bush "Pocket Manual on Heating," out of print for several years, has been reprinted. It includes sections on wet heat systems, radiation, unit heaters, pumps, specialties, control equipment, engineered radiation, blower unit heaters, special purpose pumps and related products, engineering data, and terminology.

Price is $1 per copy.

Source: *Dunham-Bush, Inc., Dept. AE, West Hartford 10, Conn.*

Folder on Ventilators

Complete specifications data, certified capacity ratings, and other information on ExitAire exhausters are contained in a recently published Bulletin 659.

Source: *ExitAire Co., Dept AE, P.O. Box 276, Pacoima, Calif.*

Cyclo-trell Mechanical Dust Collectors

Cyclo-trell mechanical dust collectors are described in Bulletin 300, published recently. The eight-page booklet illustrates and describes six types of these dust collectors.

Source: *Research-Cottrell, Inc., Dept. AE, Bound Brook, N. J.*

Improved Dust Collector

Recent improvements in mechanical dust collectors including a new involute design are described in a technical bulletin published by Research-Cottrell, Inc.

The new Bulletin 300 on "Cyclotrell Mechanical Dust Collectors" contains detailed drawings and application diagrams about the involute design recently announced by Research-Cottrell. Also included is technical information on a new hopper discharge valve and larger diameter tubes. The new involute design is specifically designed for collection of abrasive or heavy dust loadings.

Source: *Research-Cottrell, Inc., Dept. AE, Bound Brook, N. J.*

Fine Particle Measurement

"Fine Particle Measurement" by Clyde Orr, Jr., and J. M. DallaValle of the Engineering Experiment Station, Georgia Institute of Technology, discusses in detail important techniques currently used in research laboratories for the measurement of size, surface, and pore volume.

Treating both theory and application of these measurements, authors provide description of more than 70 techniques. Bibliography of approximately 400 references complements the text. Price $10.50.

Source: *The Macmillan Co., Dept AE, 60 Fifth Ave., New York 11, N. Y.*

Wanson Specification Sheets

Three new Thermobloc heater specification sheets covering models 800, 1000, and 1250 (indicating Btu output in thousands) have been issued. Each sheet contains an illustration of the model, dimensional drawings, engineering data, and details on blower assembly and controls.

Source: *Wanson Corp., Dept. AE, Charles and Juniata Sts., Lewiston, Pa.*

Hygrometric Catalog

World's first complete hygrometric catalog contains descriptions and illustrations of hundreds of pieces of moisture-detection, control, and alarm equipment. Complete systems are described, as well as individual components whereby specialized systems can be built.

Included in the new catalog, No. 660, is equipment for the measurement and/or recording of relative humidity, dewpoint, and moisture content. Individual instruments include: indicators, industrial and laboratory controllers, recorders and non-destructive package inspection equipment.

Source: *American Instrument Co., Inc., Dept. AE, 8030 Georgia Ave., Silver Spring, Md.*

Unit Ventilator Control Application Manual

Complete line of Barber-Colman automatic control systems for hot water, steam, gas-fired, and electric unit ventilators is described in detail in the new Unit Ventilator Control Application Manual.

Actual control applications are shown on each page, covering all makes marketed by the major unit ventilator companies. Complete cycles of operations, damper sequence charts, specifications for precise temperature control, and installation data are included for each.

Source: *Barber-Colman Co., Dept. AE-763, 1300 Rock St., Rockford, Ill.*

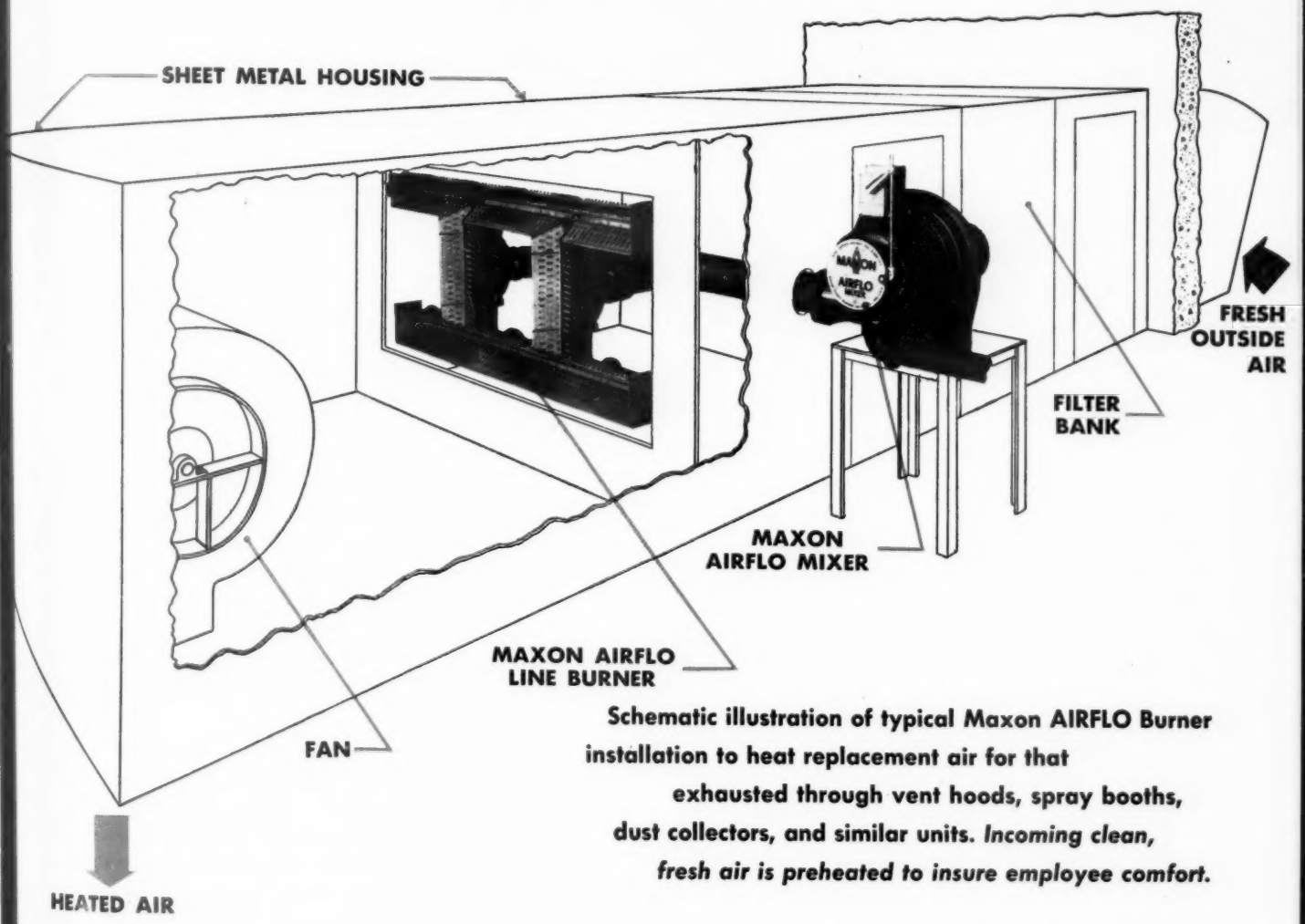
Tubeaxial Blower Sheet

A data sheet is available on the Coppus tubeaxial blower TA-16 for industrial ventilation purposes. The sheet includes specifications, dimensional drawings, performance curve graph, and illustrations.

Source: *Coppus Engineering Corp., Dept. AE, Worcester, Mass.*

NOW . . . TROUBLE-FREE ERFORMANCE OF MAKE-UP AIR SUPPLY SYSTEMS with THE MAXON AIRFLO MIXER AND AIRFLO BURNER

To Replace Air Exhausted from Factory Buildings or Process Areas



Schematic illustration of typical Maxon AIRFLO Burner installation to heat replacement air for that exhausted through vent hoods, spray booths, dust collectors, and similar units. *Incoming clean, fresh air is preheated to insure employee comfort.*

Clean, odor-free combustion . . . smooth, dependable throttling over a 25:1 range . . . positive assurance of even heat distribution across the duct with *all* burners operating *all* the time . . . simplified single bank control . . . capacities for systems from 4,000 to 200,000 C.F.M.

For complete information and application data, see your Maxon Application Engineer or write to:

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Low Cost way to sanitize hospital air with . . .

Unique Air Conditioning System for Hospitals

Fig. 1: *Infants are particularly susceptible to airborne bacteria. Even protection like the sealed viewing window shown above can't prevent cross-contamination. The air conditioning system described in this article can help alleviate contamination, however.*

*by G. Meckler**
*and M. Meckler***
Consulting Engineers

This unusual cooling and heating system for hospitals uses standard equipment to obtain central multi dew point and micro-organism control.

CONDITIONING OF HOSPITAL AIR is now considered desirable in operating and recovery rooms, nurseries, delivery and allergy rooms, and in other less critical hospital areas; i.e. patient's rooms where experience has proven its value.

Today's hospital consists of a number of isolated or semi-isolated areas each having specific requirements for air sterility, humidity, and temperature. Wide differences often exist in their respective conditions of heat release, type of occupancy, usage, and degree of contamination present.

Operating rooms, for example, have unusually high thermal load from equipment. Yet room circulation rates above 10 air changes per hour can be troublesome with some distribution systems, resulting in drafts and increased bacterial pollution of air by infected dust deposits being blown off the floor.

A temperature-humidity condition of 80 F and 50 percent relative humidity is necessary during periods of anethesia to reduce the explosion hazard from accumulated static electricity.

In nurseries the maintenance of a suitable temperature according to individual requirements with a relative humidity of about 65 percent has considerably reduced the incidence of respiratory and gastro-intestinal diseases and improved the premature infants' chances for life.[1] Air circulation rates must be adequate for odor control yet not so excessive as to create drafts. Humidity level as well plays a part in control of odors.[2]

In allergy rooms, removal of airborne pollens is the chief factor in relief of symptons. Yet exposure to dust, smoke, or gases in air, or to heat, cold, humidity, or drafts is often likely to aggravate the condition of a patient.

Numerous medical authorities agree that air conditioning in patient and recovery rooms increases comfort and stimulates recuperation. Humidity is not critical; provided, however, it is not too high. Fig. 1 lists a suggested humidity and temperature schedule for some of the important hospital areas already mentioned.

In the past, hospital requirements have been conventionally handled by central station air handling and refrigeration plants requiring either a complex of booster humidifiers for multi-room installations or individual air handling or room units with refrigeration supplied either from a central plant or separately. We have evaluated the overall requirements for hospitals in terms of proper zone control, outside air, equipment, and cross contamination effects.

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**Milton Meckler is project engineer for Meckler Engineering Co. He has participated in research to establish airborne microorganism levels in hospitals and other types of occupied space.

The Central Multi Dew Point System as illustrated in Fig. 1 represents an economical integration of conventional equipment arranged to centrally control various hospital thermal conditions and associated dew points and still provide control of air contamination without need for expensive auxiliaries.

Fig. 2 describes the individual zone air psychrometrics and lists a typical schedule of conditions maintained by this central station plant.

Unlike most conventional hospital air systems, this system will maintain independent humidity and temperature control at all required levels from one central plant.

In practice, the air washer treats and saturates the air above the required maximum dew point. A portion of this saturated air is passed through a refrigeration coil set to handle air at the lowest required supply air temperature.

Two Saturated Air Streams

Each space humidistat modulates its respective zone dampers to mix two different temperatures of saturated air to the desired supply air dew point or humidity. The zone space thermostat modulates its respective reheat coil control valve to maintain the required space temperature.

The refrigeration coil utilized to cool part of the already saturated air is always in a wet condition and, as such, does not add contamination to air. Furthermore, it may be periodically washed down without interruption of its operation and thus avoid the build up of unclean residue.

Thus control is achieved simply and with central station multi-zone equipment available in a wide range of sizes and capacities. The Central Multi Dew Point System thus eliminates the need for an elaborate network of booster humidifiers, duct coils, and accompanying air and duct contamination.

Results of recent research of hospital infections emphasizes the need to focus our attention on some probable causes of contamination by harmful bacteria, virus, spores, etc.[3] Conditions that permit the growth of harmful microorganisms in, and their transportation among, hospital areas are rapidly disappearing due to improved sterilization techniques and the concerted efforts of hospitals toward more thorough "housekeeping."[4] The latter can never be overemphasized.

Another vehicle of transported disease is by means of airborne microorganisms. First of all, airborne contaminants are present in the outside or so called "fresh" air at all times. Hospitals in areas of

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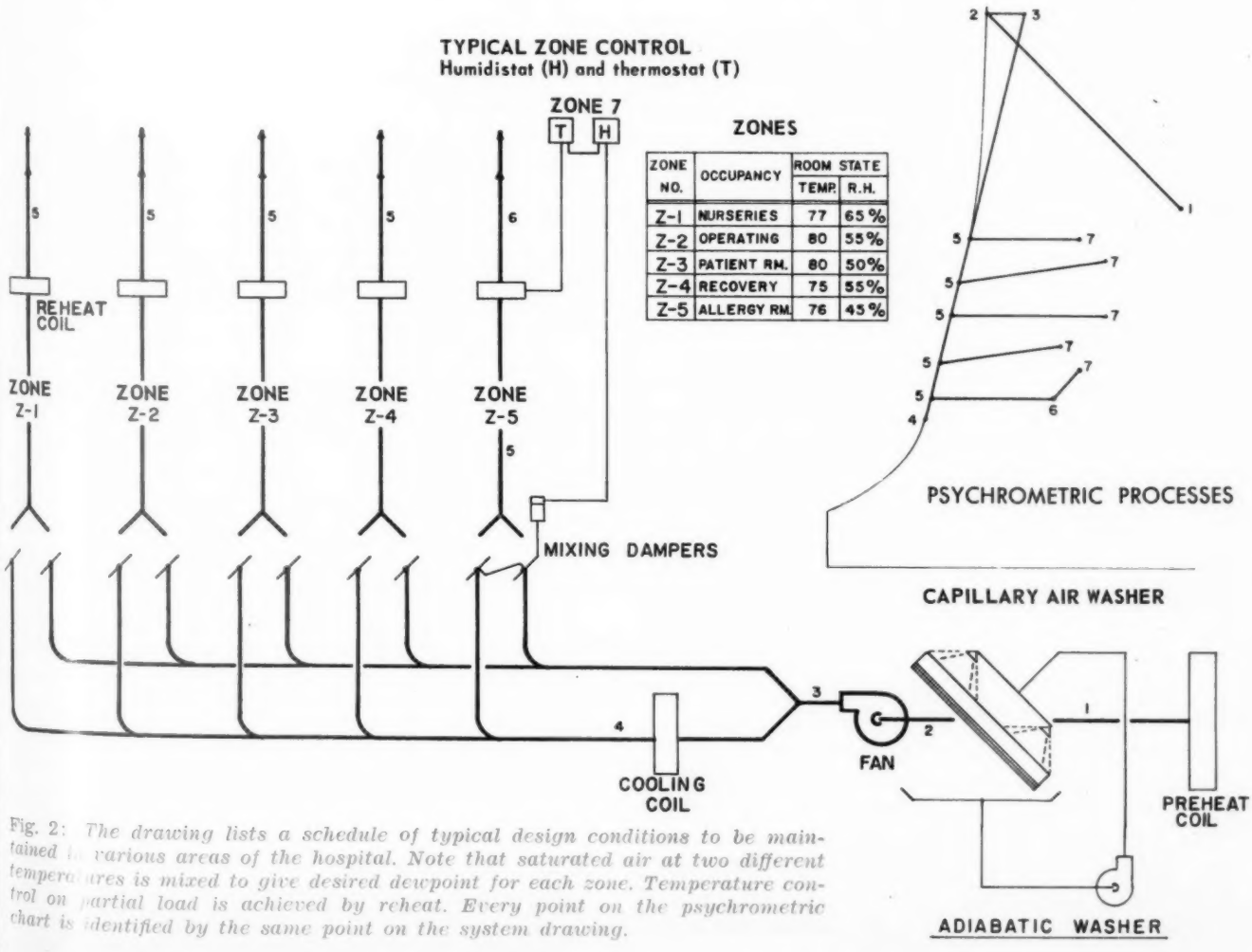

Fig. 2: *The drawing lists a schedule of typical design conditions to be maintained in various areas of the hospital. Note that saturated air at two different temperatures is mixed to give desired dewpoint for each zone. Temperature control on partial load is achieved by reheat. Every point on the psychrometric chart is identified by the same point on the system drawing.*

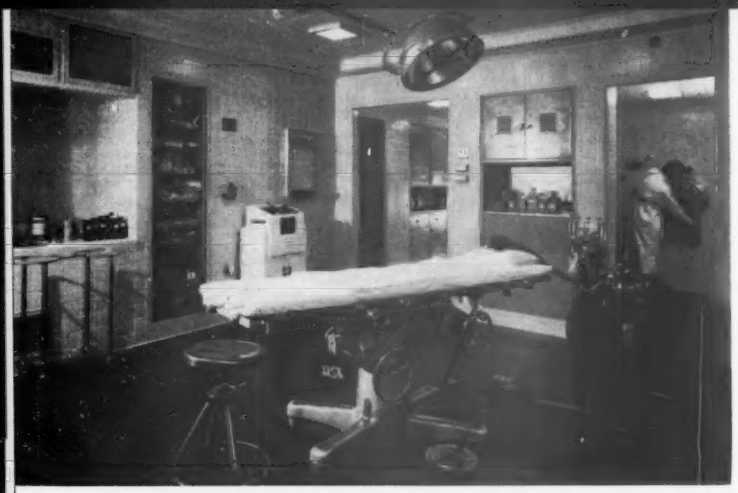

Fig. 3: *Surgical patients are also prone to airborne infectious organisms, and any air conditioning system for hospital operating rooms should also eliminate harmful microorganisms from the air.*

(Continued from preceding page)

high population density usually have higher measured microorganism levels than in less populated or non-industrial areas.

Secondly, positive air patterns caused by air conditioning equipment may inadvertently help transfer airborne contaminants into areas otherwise isolated.

Then, of course, the equipment itself may act as a site for breeding airborne contaminants by providing moist, unclean surfaces in contact with moving air streams.

Any competent method for control of hospital air must consider each of the three preceding mechanisms. Let us examine the effect of each upon the proper selection of hospital air conditioning systems.

The possibility of hospital contamination by means of airborne microorganisms present in an outside air supply should be measured at the hospital site. If the level is high, appropriate elimination steps should be taken.

Cross Contamination

To depend only upon static balance in a hospital as a positive means of controlling cross contamination is not necessarily a good assumption. Even under the best of conditions some air, however small, will vitiate into other areas and vice versa.

More significant is the constant flow of hospital personnel in and out of pressurized areas tending itself to be a vehicle of cross contamination independent of most elaborate measures and control. We must, therefore, assume that some degree of cross contamination does exist even between areas isolated by static pressure differences.

Now let us focus on the problem of the system and equipment itself as a source of contamination. Confirmation of research sponsored by the United States Department of Health, and others,[5] indicates that air can be further contaminated in unsuitable air conditioning equipment.

Booster humidifiers used in conjunction with central station equipment to permit individual zone control tend to contaminate air by exposure to the air of unclean surfaces and presents a periodic maintenance problem.

Multiple air conditioning units containing individual cooling coils for zone control cycling wet and dry under load variation tend also to contaminate air in the immediate space. They do this by entraining in the air stream unclean coil residue collected under a wet coil condition and flaked off by the moving air when dry.

Experiments conducted on refrigeration coils as they were cycling indicated this. When refrigeration coils became dry after alternately being wet the number of organisms in the air leaving the coils jumped to over 200 percent more than in the same air entering the coils.[5]

Method For Removal Of Contaminants

Up to this point we have concerned ourselves with a problem of contamination due to such external factors as outside air and equipment as well as problems of cross contamination within hospital areas. The system as outlined also incorporates a positive method of simultaneous collection and removing of airborne contaminants from the system.

It has been demonstrated that capillary air washers when filled with suitable glass fiber packing can be an effective air filter.[6] In a capillary washer the impinging air stream is mechanically broken into a large number of small filaments of the order of 0.07 in. in diameter.

Passage of these tiny air streams in turbulent flow through thoroughly wetted surfaces of varying size releases continually changing air surfaces to the scrubbing action of the glass fibers.

Once captured, airborne contamination can be eliminated from the modified capillary air washer by a number of methods:

(1) Control of the water make up and purge rate from the washer sump.

(2) Clarify recirculated air washer water by means of a filter in conjunction with submerged ultra violet lamps in sump.

(3) Controlling addition of a non-volatile bactericidal agent.

Water Make-up Rate

Water make up rate can be easily controlled manually or automatically, to produce continual dilution of the air washer recirculated water solution. In this way a relatively inert solution will be in contact with air at all times.

Dilution is necessary since normal evaporation would otherwise present the problem of an increasing concentration of contaminants in the washer sump and open the possibility for contamination downstream of this equipment.

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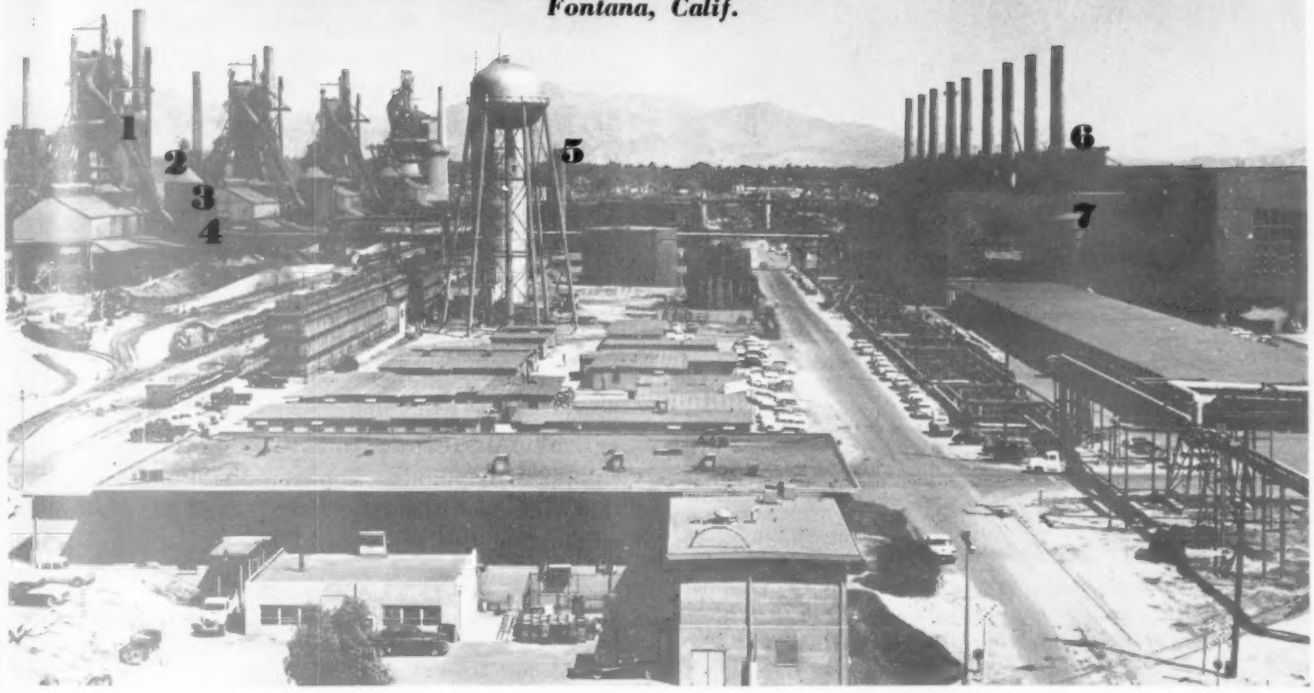
Coast's Largest Steel Plant Keeps Air Clean

by Jack Smith
Director of Air Pollution Control
Kaiser Steel Corporation
Fontana, Calif.



Above: *Wide-angle view of Kaiser Steel Mill, Fontana, Calif., shows plant in full operation without noticeable air pollution. Air cleaners are installed where noted by number:* 1. *Downcomer,* 2. *Dust catcher,* 3. *Scrubber,* 4. *Electrostatic precipitator,* 5. *Desulphurizer,* 6. *Electrostatic precipitator (one per furnace), and* 7. *Baghouse.*

How Kaiser Steel keeps its neighbors happy and their exhaust air clean points the way to practical, proved air cleaning methods for integrated steel plants old and new.

THE KAISER INTEGRATED STEEL PLANT at Fontana, Calif. is the largest of its type on the West Coast. The innumerable air cleaning problems in such a plant, from the blast furnaces to the rolling mills, are complicated at the Fontana plant by Southern California's well known inversion condition which traps air pollutants near ground level.

The solutions to these air cleaning problems, many of which were originated at this plant by Kaiser engineers, and many of which are unique at this installation, will be of interest to air engineers who have air cleaning problems of all types.

When Henry J. Kaiser ordered construction of the steel mill at Fontana in 1942 to produce steel for his Pacific Coast shipyards, he instructed George Havas, head of the Kaiser organization's engineering firm, to engineer all proved air pollution control devices into the new plant. When the plant was built in Fontana (some 45 miles east of Los Angeles), it was as clean as any integrated steel plant had been up to that time.

After World War II "smog" problems became acute in Southern California. Attention once more was drawn to air cleaning by Kaiser engineers at the Fontana steel mill. Table I summarizes sources of pollutants, type of pollutants, and solution by Kaiser engineers to control of these emissions from the various operations.

Before discussing air cleaning problems at Fontana, a brief review of the steel making process and its associated air cleaning problems may be helpful. First, tons of iron ore, coal, and limestone come into the plant daily, to be conveyed, dumped, sorted, crushed. Dust problems are self-evident.

Coal is carbonized in coke ovens, resulting in some 4.8 tons of volatile matter, dusts, and gases for every 14.5 tons of coal charged into the furnace.

Small pieces of iron ore and coke ("fines") would be blown right out of the blast furnace if charged in their undersized condition. Therefore a sintering plant lumps them into a porous mass by passing them on a moving bed under a flame. Sintering produces some sulphur gases.

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One of four blast furnaces at Kaiser Steel's Fontana plant is "cast," as 250 tons of molten pig iron are taken off. Practically all of the dust emerging from these furnaces is removed by passing through a dust catcher, a gas washer and an electrostatic precipitator. They are 99.98 percent effective.

(Continued from preceding page)

Iron ore, coke, limestone, and sinter are conveyed continuously into the blast furnace, where iron ore is reduced to pig iron. Great amounts of dusts and gases are liberated at this point.

Molten iron is refined in open hearth furnaces to make steel, during which large quantities of dust, smoke, and iron oxides are liberated.

In the new oxygen steelmaking process, problems are intensified because these new furnaces, recently installed at Fontana, use jets of pure oxygen to reduce refining time from eight to 10 hours to 30 minutes, greatly increasing output of furnace in terms of both refined steel and dust loading of emerging gases.

Description of Plant Operations

A few figures may spell out the difficulties in controlling a plant the size of the Fontana mill. Extending over 1800 acres, the plant has four blast furnaces, 10 separate rolling mills, nine open hearth furnaces, three oxygen steelmaking furnaces, 40 soaking pits and 315 coke ovens. More than 2 million tons of coal per year are carbonized in the coke ovens.

It takes a ton of iron ore, ⅔ tons of sinter, ¼ ton of limestone, ⅔ ton of coke, and 3½ tons of heated air to make one ton of pig iron in a blast furnace. Fontana's blast furnaces can produce 2.1 million tons of pig iron per year. The open hearths burn 26.5 million gallons of Bunker C type fuel oil a year.

In 1942, when faced with the problem of controlling Kaiser Steel's effluents, the engineers had little to guide them except for Henry J. Kaiser's stated desire to "be a good neighbor."

At that time there was no air pollution legislation in California. In fact, there was very little legislation or practical know-how concerning air pollution anywhere in the world.

Experts Asked to Make Survey

Therefore, a first step was to call in several air pollution scientists to survey the area and make recommendations.

At the time, Kaiser steel was using a relatively high sulphur-content iron ore in its sinter plant. Since Kaiser Steel was located in the heart of an agricultural area, and many authorities thought that sulphur compounds would probably injure vegetation, the consultants directed their efforts towards eliminating this problem of SO_2.

The sinter plant stack was built 301 ft. high to obtain better dispersion of what sulphur gases might be emitted. The Civil Aeronautics Administration would not approve the original plans, calling for a 400-ft. stack, because of danger to air traffic. As a second step to eliminate the sulphur problem, all plant railroad equipment was diesel powered.

Four Thomas continuous autometers were purchased and installed at varying distances from the mill to record sulphur concentrations in the atmosphere after the plant was completed and put into operation in late 1942 and 1943. These field tests of sulphur were made to study the effects, if any, on vegetation. Subsequent data has indicated no measurable adverse effects.

In addition to these steps aimed at reducing SO_2 problems, there were other control features, tested and proven by other iron and steel companies throughout the world, incorporated into the original designs of the plant.

For example, the blast furnace presents many problems, but is a continuous operation, and therefore relatively easy to control. By 1942, many steel companies were effectively cleaning the gases from their blast furnaces, and Kaiser Steel incorporated the latest and most advanced engineering techniques in the Fontana furnaces.

Blast Furnace Air Cleaning

Three devices are installed next to each furnace in order to clean the gases. First, the gas goes through a primary inertial type dust catcher which removes 62 percent of the incoming dust. The gas is further cleaned to 98.75 percent in a gas washer. After the gas has passed through the last cleaning device, a

pair of water film electrostatic precipitators, 99.98 percent of the incoming dust has been removed.

The dust collected in the primary dust catcher is loaded in cars through a special dustless conveyer and delivered to the sinter plant. The cleaned gases are used to heat other mill facilities.

The coke ovens are equipped with self-sealing doors. Rigid "practice" was established to insure a minimum of air pollution from this operation. Baghouses and dust catchers were designed into the raw materials system, greatly reducing the amount of ore dust getting into the atmosphere. The open hearth stacks were built higher than customary for proper dispersal of furnace emissions.

Greased slides were set out at several locations in the area to record dust fall out. On several occasions plant pathologist and citrus experts were called in to make surveys of the vegetation in the area to determine if any pattern could be found which might be attributed to mill effluents. There were few complaints from anyone about the mill.

There were still problems to be solved. Nobody had found a way to control the fine, dark red effluent from the open hearth stacks. Despite the self-sealing doors, the coke ovens were still a problem. And throughout the plant, there were areas that remained uncontrolled because control methods or devices had not yet been found by the time the Fontana plant was built.

In Kaiser Steel's Air Control and Research Laboratory, chemists perform the analytical work necessary.

(Please turn to following page)

TABLE 1 — AIR CLEANING EQUIPMENT AT KAISER STEEL MILL

Source	Pollutant	Solution
Coke ovens	SO_2	Self-sealing screw-latch doors, employe incentive system, rotary table larry cars, double collecting mains.
Incoming raw materials (iron ore, coal, limestone)	Dusts from handling, crushing, conveying	Baghouses, dust collectors, Johnson March spray systems on coal stacker.
Sintering plant	Sulphur gases, dust	301 ft. high stacks; research on uses of wet scrubbers, baghouses, electrostatic precipitators; cyclones.
Blast furnaces	CO, CO_2, sulphur gases.	Inertial dust collectors, gas washers, Research-Cottrell wet type precipitators, spray system on coke charging.
Open hearths	Dust, smoke, iron oxides, sulphur fumes	High stacks, Research-Cottrell dry type precipitators.
Oxygen steel making furnaces	Same as open hearths but with far greater dust loadings	Research-Cottrell dry type precipitators preceded by dust arrestors.
Reheating furnaces at rolling mills	Furnace emissions	Constant check to assure maximum firing efficiency.
Coal handling, coal and iron ore dumping at rotary car dumpers	Dusts, especially at coal dumper	Car dumpers equipped with Johnson March detergent spray systems.
Coal hammer mill (which pulverizes coal for coke ovens)	Fine coal dusts	Baghouse.
Foundry casting	Fine sand, silica dust	Rotoclones, shakeout table.
Carpenter shop	Saw dust	Cyclones.
Machine shop	Fumes	Collectors.
Pickling line and hot dip line at tin plate mill	Acid fumes, palm oil fumes	Mist eliminator, acid trap.
Galvanizing unit at continuous weld pipe mill	Fumes, zinc oxides	Cyclone and experimental collectors now being tested by Kaiser personnel.

(Continued from preceding page)

This was 1942-43, when the maximum effort was directed at producing steel for the war effort, rather than seeking to invent means of controlling heretofore unsolvable air pollution problems.

However, at the end of World War II, the people of Southern California became increasingly aware of a new problem – smog. Lying beneath an inversion layer at the center of a semicircle of mountains, Los Angeles developed an air pollution problem that was spreading eastward each year.

As the only fully-integrated steel plant in the area, Kaiser Steel was a readily available target for criticism, despite the fact that prevailing sea breezes obviously blew pollution towards the plant from Los Angeles, rather than vice-versa.

Air Pollution Problems Grew With Plant

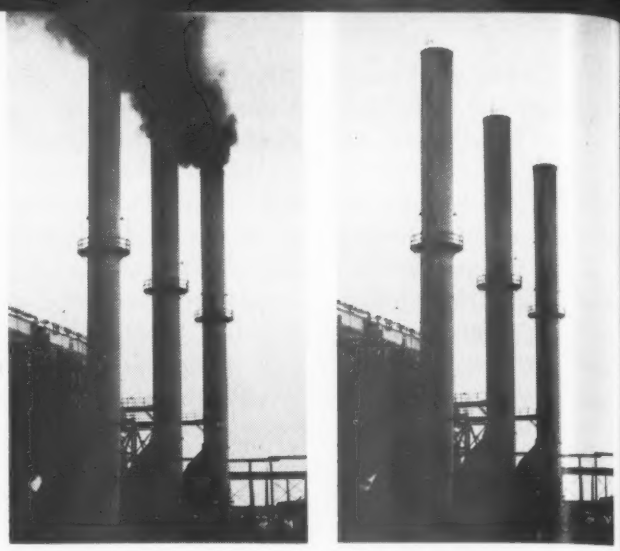
In view of the growing concern over Southern California smog, Kaiser Steel redoubled its efforts to remove itself entirely from the air pollution picture. A fume investigation group was created in the plant's metallurgical department. An outside research organization was retained to make a comprehensive study of the problem.

When reports of the research were evaluated, it became quite clear that the problem of air pollution was ever-expanding and becoming more and more complex as new information came to the surface.

Meanwhile the plant was growing – adding more blast furnaces, open hearths and rolling mills. Management realized that unless greater strides were taken in controlling the plant's effluents, the problem would get worse instead of better. There seemed to be only one solution. Kaiser Steel would have to pioneer in new methods of air pollution control. This was 1950.

The first step was to seek a way to clean the open hearth stack gases of particulate matter.

Kaiser Steel technicians observe and sample vegetation for air pollution symptoms throughout Southern California.



At left, electrostatic precipitators for the basic oxygen Steelmaking Shop are turned off, as a demonstration. Right, precipitators are turned back on. Dust loading is much greater than with open hearth units because steel is made far faster.

At Kaiser Steel, the open hearth furnaces are charged with cold steel scrap and a large proportion (67.5 percent) of molten pig iron.

Many companies have smaller furnaces using a charge of cold iron "pigs" and steel scrap. A means had been found to control the effluent from this type of furnace by 1949. But no economical, practical full scale equipment had been found for the hot metal-charge type of open hearth.

Despite this, Kaiser Steel initiated a program for the immediate design, purchase and installation of dust control equipment for all of its open hearth furnaces. The company's engineers began to work with the researchers in the field of air pollution control and with engineers from other steel companies to develop specifications for a test smoke control unit.

Kaiser Air Pollution Group Formed

Further, the fume investigation group was made into a separate air control and research department and expanded to provide the much needed test data for the open hearth research.

In 1953, a Cottrell precipitator which was installed on the No. 3 open hearth furnace at Fontana as the first step in the overall program was placed in operation.

From the outset of the operation of this unit, it became evident that stable optimum gas cleaning performance on a large hot metal-charged furnace was a more difficult and complex problem than that experienced by other steel companies in the cleaning of small, cold metal-charged furnace stack gases.

Preliminary tests run on this equipment indicated that extensive research had to be made to determine the factors influencing optimum performance.

Next month, Part II of this article will go into details on control methods. ▲▲

For pesticide research . . . "standard plants" are grown in . . .

AIR CONDITIONED PHYTOTRON ROOMS

Most cooling, heating systems have one set of design conditions. Here's a system with almost infinitely variable design conditions over a 24-hour period . . . and how a practically zero temperature gradient system was designed to meet these grueling conditions.

by W. H. Minshall, Ph.D
Senior Plant Physiologist
Pesticides Research Institute
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FROM MIDNIGHT TO NOON, dark sky or bright, there are four small (but costly) rooms at the Pesticide Research Institute, London, Ontario, Canada, which can duplicate around-the-clock climate and light conditions over a wide range of physical conditions for plant pesticide research. Chart A shows a typical control program.

The heating, cooling, humidification and complex control equipment set-up, while unique to these Phytotron plant rooms, may well have other applications to today's environmentally controlled research laboratories.

Briefly, reason for the small plant rooms is to provide a controlled environment in which "standard" plants can be grown under known conditions. Plants are used for biochemical and physiological investigations, and as food material for insects and fungi under test in other parts of the Institute.

Studies in the plant environment rooms also include plant transpiration, metabolism, photosynthesis, and reactions of plant and soil to various pesticides. Relative humidity control is important in transpiration studies involving water relations of plants to ambient conditions.

From this summary of room usage, we proceed to a description of the environment rooms themselves.

Each plant environment chamber, or room, (Fig. 1) is 14 ft by 15 ft, divided into a light section 12 ft by 14 ft, a dark section 3 ft by 11 ft and a connecting corridor 3 ft by 3 ft. These rooms are located in the basement and have air-tight doors.

The "ceiling" of the light room section is removable waterwhite plate glass. Above the glass there is a "light loft" containing racks of 96T8 slimline cool white fluorescent tubes placed on 2 in. centers, with a row of four or six 60 watt neck reflector incandescent bulbs replacing every twelfth fluorescent tube (Fig. 2). Incandescent lights provide some red to help duplicate natural sunlight conditions.

A minimum of 2500 ft-c of light at plant level is provided by the tubes in the "light loft," about one fourth the intensity of sunlight.

About three fourths of the room is illuminated in this manner. There is also a rack of similar lights mounted below ceiling level and adjustable as to height by means of a geared winch and cables, to obtain high light intensities (Fig. 3).

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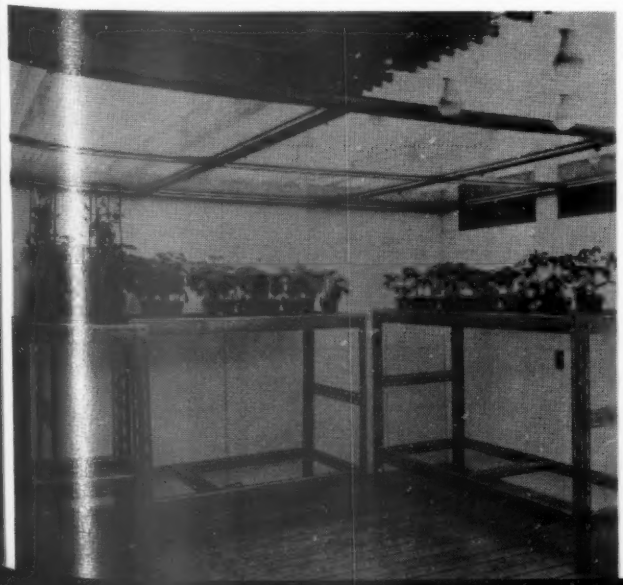

Fig. 1: ***"Standard" plants grown under controlled conditions in the "light" room are used for pesticide research. Air is introduced into room through channels in floor, removed through high side wall registers shown at top right. Light Loft has separate system.***

Fig. 2: *The light loft in the "light" room has ceiling of closely spaced fluorescent lights above sealed, glass ceiling. Light loft area has separate cooling system from room proper.*

Fig. 3: *Below, about one fourth of the room has an illuminated ceiling adjustable as to heights, as shown here, to obtain high light intensities.*

(Continued from preceding page)

Lights can be programmed over a 24-hour period (along with the climate control system described later) to simulate varying light conditions during a normal outside 24-hour period. This requirement of course poses a varying light load heat gain problem.

In addition, about 15 percent more light than normal is squeezed out of the fluorescent tubes by operating them at 430 ma. This again raises the heat gain from lamps, even though lamp ballasts are located outside the conditioned areas.

Lighting program can be controlled automatically by three 24-hour time clocks, which switch lights on or off in alternate tubes or combinations.

The variable light load, plus a need for reducing radiant heat from lights to plants, and a need for keeping lights as cool as possible to offset their operation at above design light output, called for a "light loft" area cooling system.

This operates fully independently of the room system, since both systems have totally different cooling requirements. The light loft is physically sealed from the room by the waterwhite glass ceiling.

We will return to a description of the light loft cooling system after describing the physical set-up in the plant environment room just below the glass ceiling.

The "light" rooms have walls of white carrara structural glass, which serve to even out light within the room, and to provide a sterilizable wall surface.

Paint would mold and provide a foothold for algae. And the glass walls are practically maintenance-free.

As mentioned earlier, the rooms call for a controlled climate to simulate outside conditions. Temperature is controllable and programmed from 40 to 90 F with floor to ceiling temperature gradients of from 2 to 4 F at steady state as well as under programmed changes.

Relative humidity is variable from 50 percent to 90 percent. Air changes are variable from 30 to 130 changes per hour, and represent 2500 cfm for light section, 500 cfm for dark section, or a total of 3000 cfm per chamber.

Conditioned air is introduced into and removed from the room so as to minimize radiant heat absorption by plants, floors, and walls.

From zero to 20 percent of the circulating air can be exhausted and a similar amount of preconditioned outside air added.

And the heat extracted from the environment rooms can be fed into the separate conditioning system which heats and cools the laboratory and office section of the building.

'Light' Rooms Cut Research Time

Because the environment rooms can reduce research time to one half or less of that required to study plants under conditions containing less controllable variables of light, heat, humidity, and air movement, any failure of the climate control system could result in a six month's set-back in research.

For this reason both standby electrical power source, and standby refrigeration compressor equip-

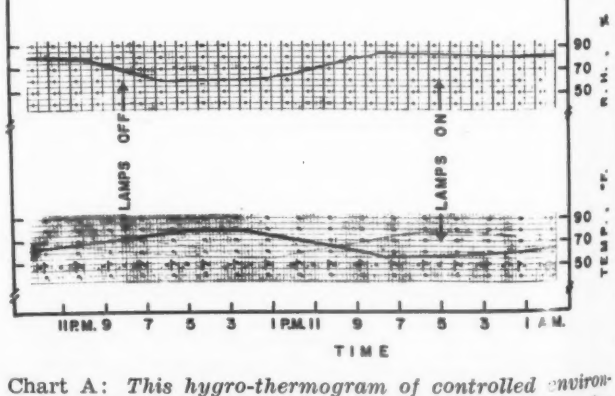

Chart A: *This hygro-thermogram of controlled environment "light" room was set to follow a "typical" June day at London, Ont.*

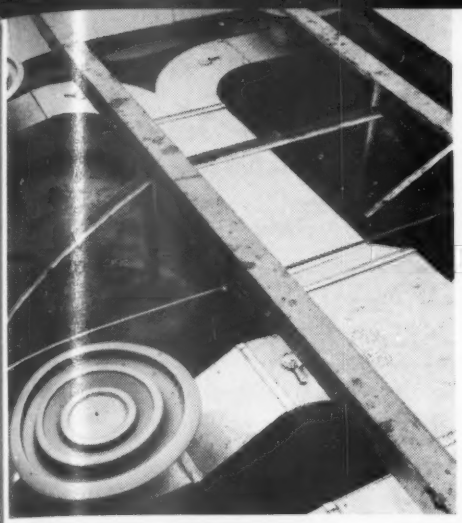

Fig. 4: *Left, this photo is not upside down. It shows how air is distributed through under-floor outlets to feed upward through spaces between floor channel members as shown in Fig. 1.*

Fig. 6: *Lights can be programmed over 24-hour period by the recorder-controller equipment shown above. Temperature and humidity changes over 24-hour period can be duplicated in "light" rooms by this specially designed control system.*

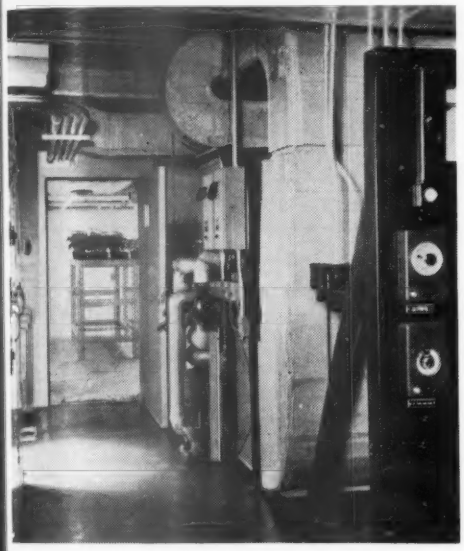

Fig. 5: *Individual air handling units are provided for each of the "light" rooms. Above is shown one such unit. Note multi-speed blowers at top, as evidenced by speed control knobs just under U-shaped duct at top.*

ment are always ready to take over the load.

The small dark room is used separately from the light room when simultaneous daylight and night conditions are to be duplicated. Environmental conditions in both light and dark rooms, however, can be the same if desired.

There are no special air filtration requirements beyond those which can be accommodated by standard, cleanable filters.

In considering design of the system and selection of the various mechanical equipment serving the four plant environment rooms, cost was considered only in relation to what was needed to accomplish the climatic conditions spelled out up to this point.

Before describing how the problems posed thus far by the climate control requirements were solved, a brief description of the mechanical equipment selected is in order.

The standby power plant consists of two 219 kva, diesel powered generators in an equipment room adjacent to the boiler room. A qualified stationary engineer is on duty 24 hours a day, seven days a week, in the event of a power failure, or any other type of equipment failure, to change over to the diesel plant.

Two refrigeration compressors in the power plant room chill direct expansion coils in a liquid-to-liquid heat exchanger, chilling a 35 percent water-glycol solution to 36 F. with return solution to heat exchanger maintained at about 44 F. One compressor can handle up to three fourths of the peak load, and both are piped to permit paralleling.

Boilers provide steam to a heat exchanger which heats a 33⅓ percent glycol solution to 150 F.

Individual air handling units (Fig. 5) are provided for each of the four environmental room areas. The light loft has an individual air handling unit. The outside air tempering system also consists of an individual air handling unit.

Circulating mains provide hot or chilled glycol solution to coils in the air handling units. Each coil in each air handling unit has a separate circulating pump.

Dark rooms have a separate coil to provide reheat to compensate for lack of heat gain from lamps, and to duplicate conditions in the light rooms.

All of the environmental rooms, light loft, make-up air systems, and associated mechanical equipment are completely separate from the system serving the rest of the building.

Separate Systems for Light Loft

Returning now to the light loft, heat gain from the lights is removed by a separate air handling system. It is balanced with the number of lights on at any given time by modulating dampers in the supply air stream. A bulb in the return air stream controls the air handling units. The light loft system handles 100 percent recirculated air.

In the light section of the environmental rooms, controlled air is introduced into an underfloor plenum, formed by spaced channels, through slots between the 3 in. wide channels, as shown at bottom of Fig. 1.

Air is introduced to what amounts to a full underfloor area plenum, from ducts with four outlets dis-

(Please turn to following page)

(Continued from preceding page)

charging upwards against a conical spreader, as shown in Fig. 4.

Introducing chilled air through the floor keeps the steel floor cool and reduces radiant heat absorption by the floor. Careful analysis has proved that the temperature gradient in these rooms is low at all times.

Air is recirculated by means of high wall registers placed just underneath the glass ceiling, as shown at top left of Fig. 1. From return air registers, air is ducted back to the air handling unit where exhaust fan removes part of the air and variable speed damper adds outside air.

Room temperature is maintained by electronic temperature sensing element. Humidity control is by electronic humidity sensing elements. These elements, mediated by recorder-controllers, control throttling valves in the hot and cold glycol lines to coils in the air handling units, to provide mixtures of heated and cooled glycol as needed.

The control index of the recorder-controller is reset by a programming unit (Fig. 6). This unit, built to specifications of the Pesticide Institute, provides for 24-hour programming of both temperature and humidity, with rate of rise, rate of fall, and constant hold being provided for.

An auxiliary recording device is also provided which consists of a 72 plug jack board thermocouple station and a 12 point recorder. This permits recording spot temperature of any 12 places in any of the four rooms. It is used for taking soil temperatures, testing lamp temperatures, leaf surface temperatures, etc.

The air handling units are vertical type, have sprayed coil dehumidifier and dry heating coil, V-type cleanable filters, variable speed motor driving two main fans by V-belt drive and exhaust fan by direct drive. Provision is made for up to 20 percent outside air.

There are relatively few plant environmental or Phytotron rooms anywhere. A new room of this type is now in the design stage, and will be constructed soon as part of the new Pharmacy Research Building at University of Michigan, Ann Arbor. Consulting engineer will be Benedict & Associates, Inc., Detroit.

This article was presented in the hope that engineers faced with the problem of designing environmental laboratories of all types for today's research will find helpful data in what was done in one such laboratory. ▲▲

EQUIPMENT CREDITS

Refrigeration Compressors: *The Trane Co.* (environmental rooms); *Worthington Corp.* (offices, other labs).
Air Handling Units: *Governair Corp.*
Temperature and Humidity Controls: *Minneapolis-Honeywell Regulator Co.*
Pneumatic Valves and Dampers: *Minneapolis-Honeywell Regulator Co.*
Programming Recorders and Controllers: *Brown Instrument Div., Minneapolis-Honeywell Regulator Co.*

Volatile Dust Removal With Wet Collector

A volatile dust hazard at the Akron plant of the General Tire and Rubber Co. was traced to a gasoline base lubricant.

Lubricant is used to prevent sticking, is made of soapstone and mica suspended in gasoline and sprayed onto tires before tires are placed in molds.

After tires are formed, they move on conveyor to the lubricant spray station, where two fixed spray guns apply lubricant to tire exterior. Inside of tire is coated by hand-held spray gun.

A baffled hood, Fig. 1, draws overspray to the back and top of the station, directs dust laden air through a duct into inlet chamber of wet dust collector.

Collector (Fig. 2) operates under suction from an exhauster which produces negative pressure in inlet chamber. Dust laden air, expanding rapidly after passing through collector tubes, loses velocity, permitting heavier particles to settle out into a water sludge accumulator.

Sludge is deposited on impingement surfaces of collector, is washed down into the tank and settled to bottom for removal by conveyors. ▲▲

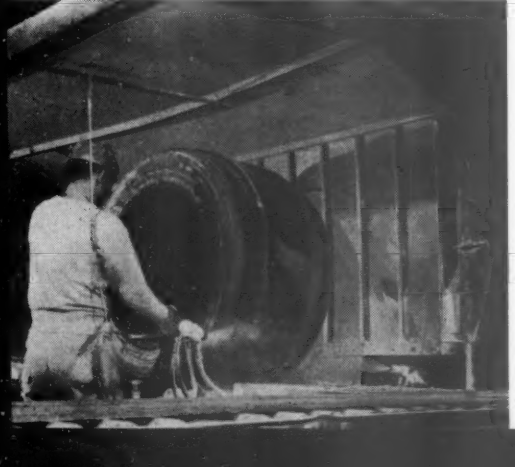

Fig. 1: *At left, a 10.00-24 L.C.M. truck tire is sprayed with fine soapstone-mica - gasoline solution lubricant, after forming application at General Tire and Rubber Co., to prevent sticking. Photo courtesy Pangborn Corp.*

Fig. 2: *At right, volatile overspray and dust is collected in self-contained wet dust collector. Photo courtesy Pangborn Corp.*

For the air engineer

by C. O. Wood
Manager, Engineering Laboratory
Westinghouse Electric Corp.
Sturtevant Div.

Techniques for Designing Duct Systems

Latest methods for duct-work design. Includes data on minimizing energy losses due to friction and dynamic losses due to duct turns, take-offs, entrance and exit shapes, approaches and discharges from fans and equipment.

THE DESIGN OF DUCTWORK for moving air is intended primarily to produce an efficient system with a minimum of losses. The energy losses in a duct system are of two types. Those classified as frictional are due to the contact of the moving fluid against the walls or surfaces of the container. The friction depends on the roughness of the wall surface, the contact area, the square of the velocity, and the density of the fluid.

$$\text{Friction loss} = H_1\text{-}H_2 = f\,\frac{L}{D}\rho\left[\frac{V}{1096.5}\right]^2$$

where f is a coefficient depending on wall roughness and Reynolds Number.

The dynamic losses in a system are due to a change in velocity of the fluid such that the conversion between velocity pressure and static pressure is not 100 percent efficient.

The amount of loss varies with the type of velocity change, e.g.: divergent, convergent, abrupt, gradual, etc. and is generally cataloged in terms of velocity heads.

$$\left[\text{One velocity head} = \frac{V^2}{2g}\right]$$

$$\text{Loss} = C^1\left[\frac{V^2}{2g}\right] = C\,\rho\left[\frac{V}{1096.5}\right]^2 = \text{inches of water}$$

where C is an experimentally determined factor, ρ is density of the air in lb/cu ft, and V is velocity in ft/min.

Of course in most cases the losses are both frictional and dynamic and so the total loss is their sum. Since the system losses have a direct bearing on both original cost and on operational cost, the designer should pay careful attention to the methods of reducing losses.

Generally speaking, frictional losses are automatically tied down by restrictions on duct size due to

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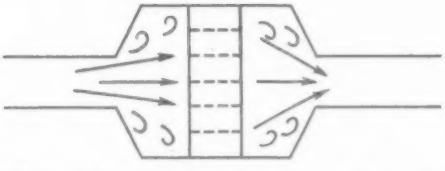
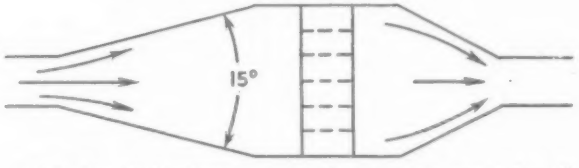
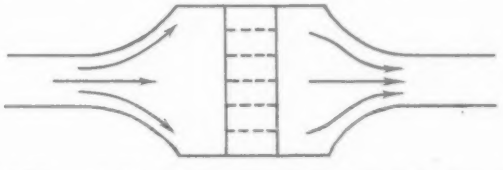


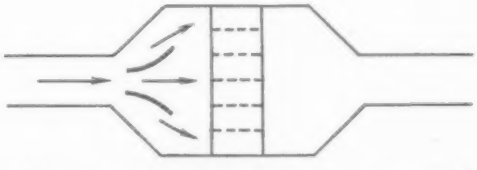
(a) With sudden enlargement air continues to flow mainly through center area.



(b) Gradual enlargement allows air to spread uniformly.



(c) Curved duct sides encourage the air to spread.



(d) Baffles are a practical solution for poor distribution in installed ductwork.

FIG. 1 AIR FLOW THROUGH ENLARGED DUCT SECTIONS.

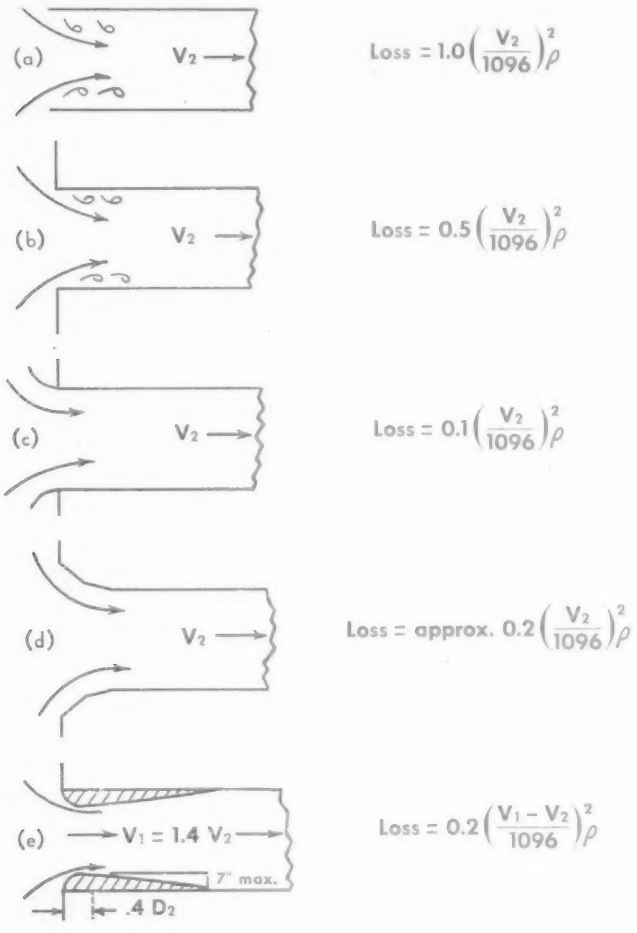


FIG. 2 ENTRANCE LOSSES AT DUCT OPENINGS.

(Continued from preceding page)

space available, noise limitations, installation costs, or restrictions on equipment location.

However, the dynamic losses can often be reduced by proper attention to duct turns and takeoffs, entrance and exit shapes, approaches and discharges from fans and equipment.

A good guide to keep in mind in duct design is to avoid wherever possible sharp or sudden changes in air velocity or direction. If the sudden change is necessary then reduce the higher air velocity by using a larger opening or duct.

EQUIPMENT	RECOMMENDED VELOCITY RANGE FPM	
	Low Velocity Systems	High Velocity Systems
Outside Air Intakes*	300 - 1500	300 - 1500
Filters*	300 - 1000	300 - 1000
Heating Coils*	300 - 1000	300 - 1000
Cooling Coils*	300 - 700	300 - 700
Air Washers	500 - 750	500 - 750
Fan Outlets	1300 - 2800	1300 - 2800
Main Ducts	1000 - 2400	2500 - 4500
Branch Ducts	600 - 1600	2000 - 4000

NOTE: *These velocities are based on total face area, not the net free area.

FIG. 3

This is an important point. Since the losses are proportional to the square of the velocity, sizeable reductions in loss can be obtained.

The designer should bear in mind, however, that merely enlarging a passage a short length does not always mean that the air will follow this path.

Fig. 1(a) shows how an enlargement in a duct may be disappointing in the reduction of pressure loss. In a too sudden enlargement the air flow separates from the side walls and the original high velocity

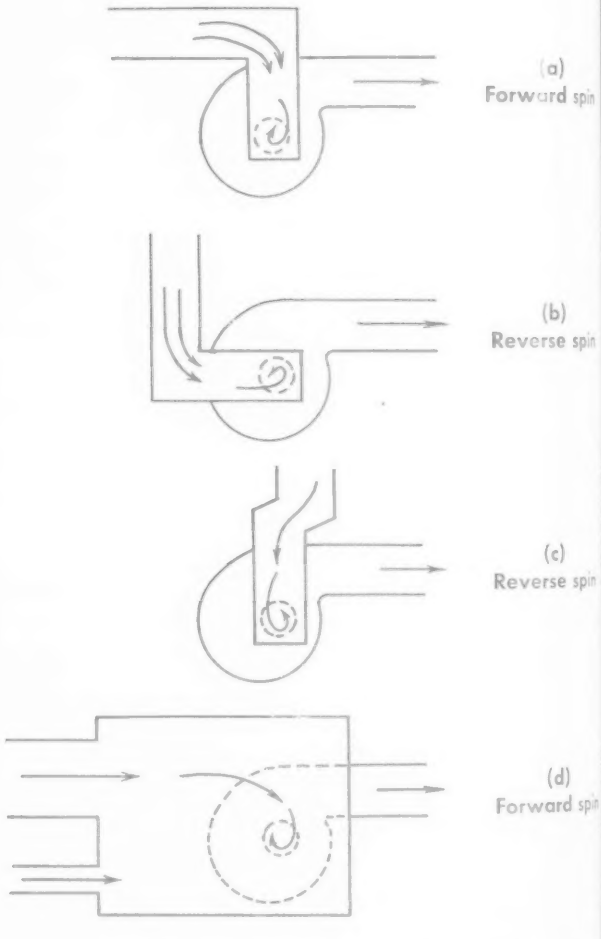


FIG. 4 CONDITIONS LIKELY TO CAUSE SPIN AT FAN INLET.

continues through the center of the section.

An angle of divergence of 7½° (15° included angle) with the axis is the maximum that the air will follow. A slightly steeper angle is permissible on the converging side because the air will tend to follow the walls more readily when the velocity is increasing.

When space limitations prohibit the longer transition, curved sides as shown at (c) or baffles as at (d) will provide considerable improvement.

Air entering an opening from a larger space will produce a vena contracta (Fig. 2(a) as it enters and a considerable loss can result unless the opening is properly rounded.

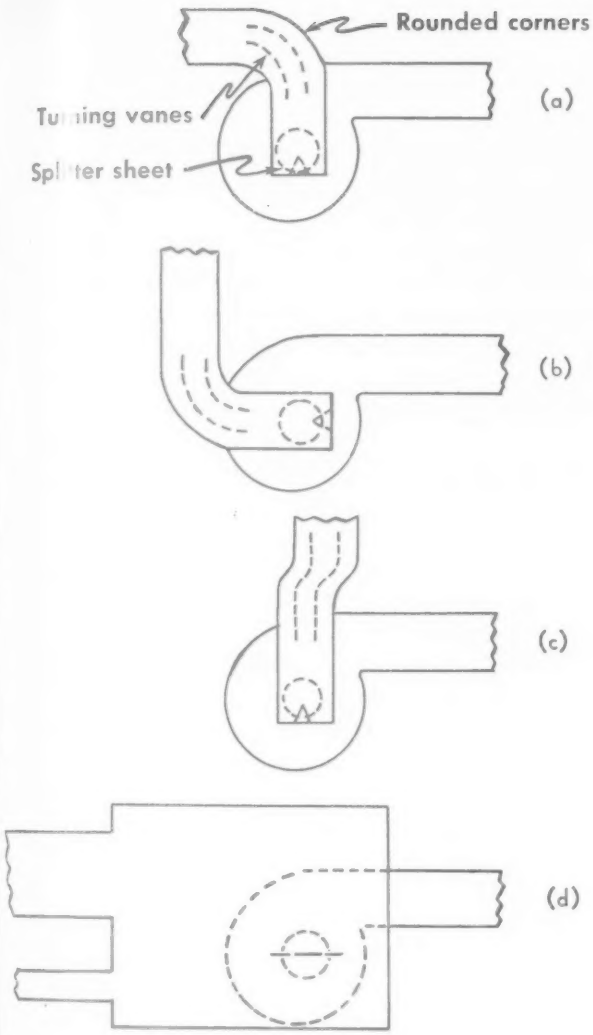


FIG. 5 IMPROVED DESIGNS TO DISCOURAGE INLET SPIN.

The revisions at (b) (c) (d) and (e) will improve this situation. Another alternative as mentioned before is to increase the opening size and thus reduce the velocity. The free area of the opening is the governing factor. If a grille is used the net area and the shape of the solid parts (eg. sharp edged or well rounded) determine the velocity and resultant loss.

The guiding criteria for reduced losses in ductwork are to hold the velocity low and make any turns gradual. An abrupt change in direction or velocity is undesirable.

The designer must balance the cost of refinements against requirements of the job.

There are, of course, practical limits to the minimum velocity used in ducts. Recommended velocities are given in Fig. 3.

The various pieces of equipment included in a duct system for the purpose of conditioning the air produce losses in varying degrees. The loss is practically always a combination of dynamic and frictional type. For simplicity the two types are usually combined into one and referred to as "pressure loss."

Air cleaning devices, heating and cooling coils, sound attenuators and, in fact, any device placed in the air stream creates a loss of greater or less degree depending on the shape and amount of blockage created.

Air cleaners such as the impingement type filter depend for their cleaning action on a change in direction of air flow. This change in addition to the friction loss through the passages results in the loss across the filter. The eliminators used on the downstream side of the air washers also produce a loss in a similar manner.

The losses in heating and cooling coils are due to friction and to turbulence created to promote heat transfer.

The resistance to air flow produced by all this equipment will increase as dirt builds up on the surfaces and thus reduces the free area. Moisture collecting on a cooling coil will also block the air flow unless the coil is properly designed to drain this water off rapidly.

Sound attenuators are made in roughly two forms. Insulation lining a straight duct creates a frictional resistance which is somewhat more than a plain metal duct. The other form contains insulated cells of vari-

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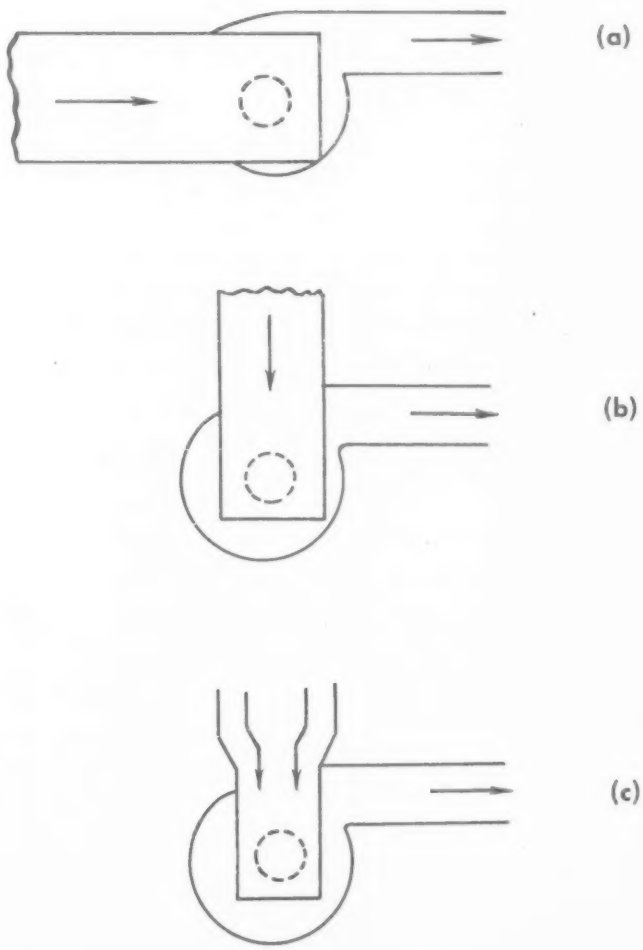

FIG. 6 IMPROVED INLET CONDITIONS.

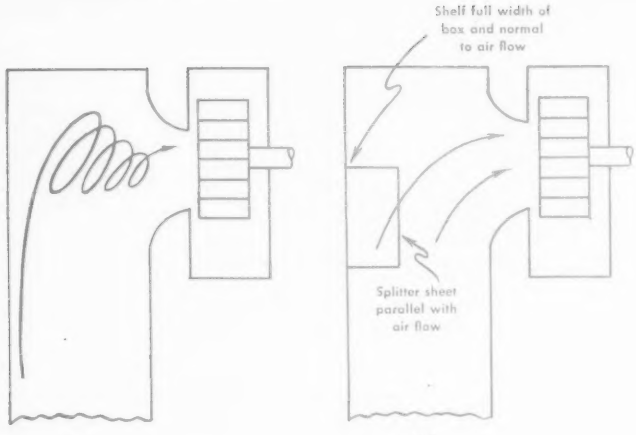
Shelf full width of box and normal to air flow
Splitter sheet parallel with air flow
(a)
Vortex forms at fan inlet
(b)
Shelf & splitter sheet to discourage vortex formation

FIG. 7 EXAMPLE OF VORTEX FORMATION IN INLET BOX.

(Continued from preceding page)

ous shapes which create both dynamic and frictional resistance.

The manufacturers of the equipment described above provide the pressure loss data and should be consulted regarding their product.

The approach to and discharge from the fan are important parts of the duct system. They can lead to serious complaints against an otherwise good system and can account for a reduction in fan performance of as much as 25 percent.

To understand the effect of the approach and discharge, it is well to review the basic fan action. A fan transfers energy to the air by creating a vortex or whirling flow which, in the ideal situation, is converted to static pressure in an orderly and controlled manner. If the duct connections at the fan entrance or exit interfere with this action, then the performance may be altered considerably.

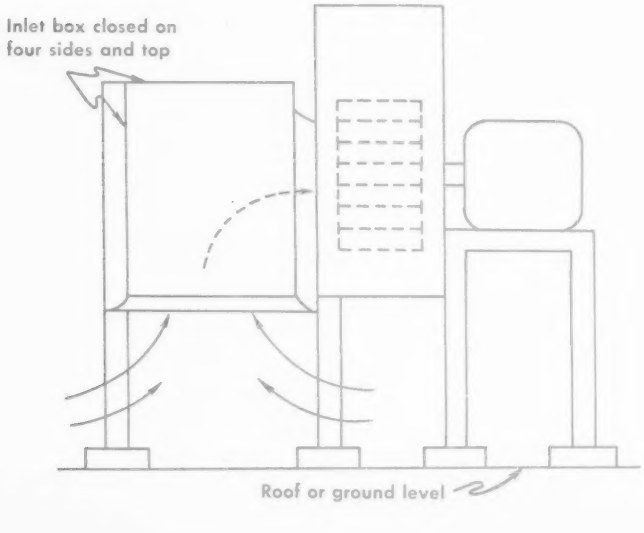

FIG. 8 TYPICAL OPEN AIR INSTALLATION.

The ideal approach to a fan is such that the air enters the inlet axially without spin in either direction. A spin in the same direction as the fan rotation will reduce the pressure output and will be accompanied by a reduction in horsepower. The abnormally low horsepower is usually a good tip off that an inlet forward spin exists.

A reverse spin at the inlet results in high horsepower with very little increase in pressure. Here again abnormally high horsepower may indicate a reverse spin at the inlet.

An inlet spin may be caused by a number of different approach conditions and the actual cause may not be too obvious. Fig. 4 shows several conditions which will contribute to an inlet spin.

An inlet spin can also be caused by apparatus which produces an unbalanced flow of air into the fan plenum. Heat transfer coils, for instance, which have become excessively dirty on one end might create such a condition.

Fortunately an inlet spin can usually be corrected by use of proper baffling or vanes.

In Fig. 4 (a) and (b) turning vanes should be installed in the elbows and, at (c) vanes should be used in the transformation piece to guide air straight into the inlet box. In all three cases a splitter sheet should be installed at the bottom of the box. Fig. 5 shows these additions by dotted lines.

Of course it can be said that better basic designs in these three cases would be to bring the ducts

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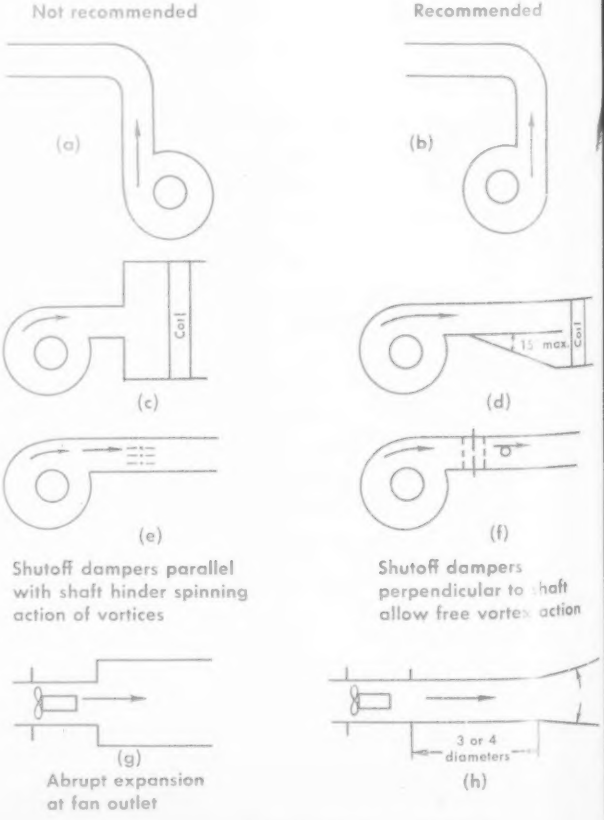

FIG. 9 FAN DISCHARGE DUCT DESIGNS.

Duct Design Methods

(Continued from page 32)

straight to the fan as shown in Fig. 6.

A spin can often be corrected by use of baffles or vanes at the fan inlet. A flat plate across the inlet may be enough to discourage the spin.

The plate must be oriented with the inlet flow so as to discourage the spin without obstructing the flow. If the spin is persistent it may be necessary to install fixed inlet vanes set either axially or to produce just enough counter spin to offset the original.

Occasionally a new system will exhibit a pulsating flow and the fan appears to be "gulping" as though starved for air. Usually the noise and duct vibration created by this action give rise to the first complaint.

Assuming the fan is operating on the stable portion of its curve, the culprit in this case is most often a transient vortex which forms in the inlet and is carried rapidly through the fan where the normal action is severely disrupted. Very shortly thereafter another vortex forms and the maelstrom continues.

The cure for this trouble is often the proper placement of baffling in the inlet box so as to discourage the vortex formation. The air should be guided definitely into the fan, per Fig. 7.

Pulsating flow may also be caused by wind pressure, particularly with low pressure fans. Good practice favors locating the inlet in a protected location where the full wind blast is not felt.

Rooftop Installations

Fig. 8 shows a common type of installation used on roof tops. Equipment having a sizeable resistance, such as finned coils, when installed ahead of the fan will help to reduce pulsation caused by gusty winds.

In the ideal situation, the fan discharge should be a straight duct about six diameters long and of the same area as the fan outlet.

The air leaving the fan outlet still has a considerable amount of velocity energy not yet converted to static pressure. The energy is in the form of vortices which must be allowed to slow down in a somewhat regular fashion to realize the maximum conversion.

Since there is seldom sufficient room in the actual installation to allow the desired straight duct length, a loss must be charged depending on the severity of deviation from the ideal.

The loss can be approximated in most cases by considering the dynamic losses described above for various section changes.

For instance, if the fan is discharging directly into a large plenum, the loss would be essentially equivalent to the velocity head based on the fan outlet velocity. In fact, it is reasonable to allow this same amount of loss for most discharge conditions which depart radically from the ideal.

Diagrammed in Fig. 9 are a number of different discharge conditions as a guide to good design. ▲▲

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Process air conditioning . . . a case history in an

Air Conditioned Capsule Factory

by Adam Dargas
Maintenance Superintendent
R. P. Scherer Corporation

This modern plant of the R. P. Scherer Corp., Detroit, houses a battery of air conditioned capsulating machines that make pharmaceutical capsules. In foreground is a spray pond for condenser cooling water.

How this capsule plant maintains precise temperature, humidity, air movement control at its capsulating machines is a process cooling story in a capsule of value to any air engineer who uses chilled air for production.

A PHARMACEUTICAL MANUFACTURING firm that gets the last ounce of work out of the conditioned air in its plant is the R. P. Scherer Corp. in Detroit.

Scherer produces soft gelatin capsules and fills them with vitamins, medicines, food products, and such special items as bubble bath and chicken fat.

The machines that capsulate these products demand air precisely controlled for temperature, humidity, and even static pressure to operate properly. For sanitary reasons, the air must also be filtered to keep dust and foreign particles off the products.

After performing its function in the capsulating machines, this conditioned air is heated and used again to partially dry moist capsules in whirling drums. Then it is used a third time, after filtering, to complete the drying process in drying tunnels. Only then is it returned to the refrigerating equipment for reconditioning and another cycle of work.

Briefly, the capsulating process works this way. Warm liquid gelatin is spread over a slowly revolving stainless steel drum about 24 in. in diameter. Over this drum 400 cfm of 57 to 59 F. air at 20 percent relative humidity is blown.

The chill, dry air congeals the gelatin as the drum rotates so that a tacky, elastic band rolls off the other end. This thin band is then automatically formed into capsules; filled with medicine, food, or other product; sealed; and dropped into a tray.

If air blowing against the drum has too low a temperature, gelatin will set too rapidly. Then it becomes brittle and the ribbon breaks, stalling the manufacturing process.

Too high an air velocity will disturb the constant thickness of the gelatin ribbon being formed. If air temperature and humidity are too high, or air velocity too low, the gelatin will not solidify into a ribbon, with equally disastrous results.

Thus the need for constant air control.

From the capsulating machines, the soft, moist capsules are automatically transferred to squirrel cage drying drums for rapid drying and then to drying tunnels for hardening.

Scherer now has 48 capsulating machines, plus dryers and drying tunnels, in a 180 by 240 ft. room. The machines are lined up in four rows. There is enough space for 16 additional machines in present lines.

Actually, two separate, but interrelated air cooling systems are used to create the air conditions demanded by the capsulating machines.

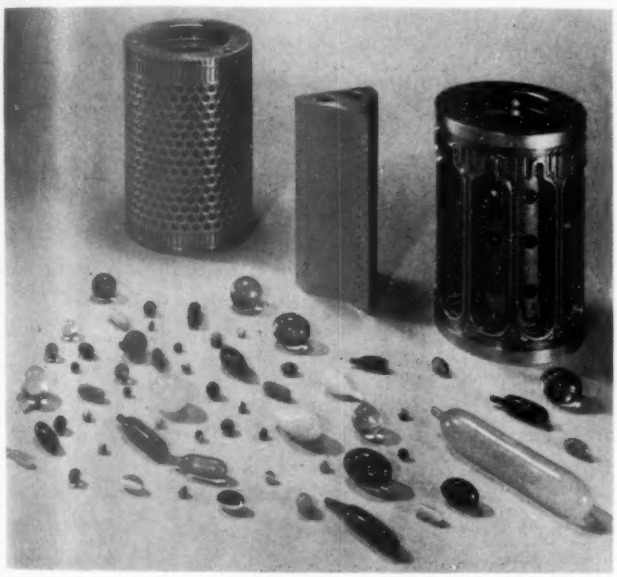
One is an air cooling and drying system using lithium chloride spray humidity control units and refrigeration equipment. The other is a chilled water cooling system that not only helps provide cooling for the machines, but air conditions offices and laboratories as well.

Machinery for the humidity control system is

housed at the rear of the one-story plant, just behind the capsulating room.

Two 50 hp. compressors and three humidity control units are located in one room and two 50 hp. compressors and one humidity control unit in another. In an outdoor area between these rooms are two evaporative condensers and a cooling tower. The cooling tower is used with the make up air unit and the evaporative condensers with the recirculated air units.

The equipment in the first room serves 32 of the capsulating machines. The equipment in the second room handles the other 16. Provision has been made here for the addition of another humidity control unit to handle an additional 16 machines.



Just a few of the many capsules and capsule dies (at top) made at the R. P. Scherer Corp. Air must move through capsulating machines at exactly the right velocity, temperature and humidity to control the warm liquid gelatin in machines.

In the first room, two of the three humidity control units chill, filter, and dehumidify 35,000 cfm of recirculated air. The third conditions 12,500 cfm of outside air.

A separate humidity control unit is used for outside air because a single pass through the unit is not sufficient to reduce humidity level to the necessary 20 to 22 percent, especially on humid days.

After passing through this unit, the air is then mixed with recirculated air and passed through another humidity control unit for final conditioning to 60 F and 20 percent relative humidity.

A blower then drives the conditioned air to an underground pit where four chilled water coils hooked up in series are located. Passing through these coils reduces air temperature to 57 F.

Chilled water coils are used for final temperature control because the humidity control system itself cannot hold, under varying ambient conditions, the

Close-up of typical capsulating machine. Chill, dry air, passing over revolving steel drum covered with liquid gelatin, congeals gelatin as drum rotates so tacky, elastic band rolls off at other end, where capsules are formed.

precise temperature required.

Flow of 42 F water through the coils is modulated in response to a thermal bulb downstream from the coils. Indicator is in the capsulating room.

Similarly, the humidity control unit in the second room conditions 17,500 cfm of recirculated only. This air, too, is driven to an underground pit where it passes over four chilled water coils.

The four coils were installed in anticipation that a second humidity control unit will be needed later. The pit is rather difficult to get to, and it was felt it would be better to do the entire job at one time.

Using four coils instead of one large coil also acts as a safety factor. If one of the coils develops a leak, the others can carry the load, allowing production to continue.

From each pit, the tempered air is fed through

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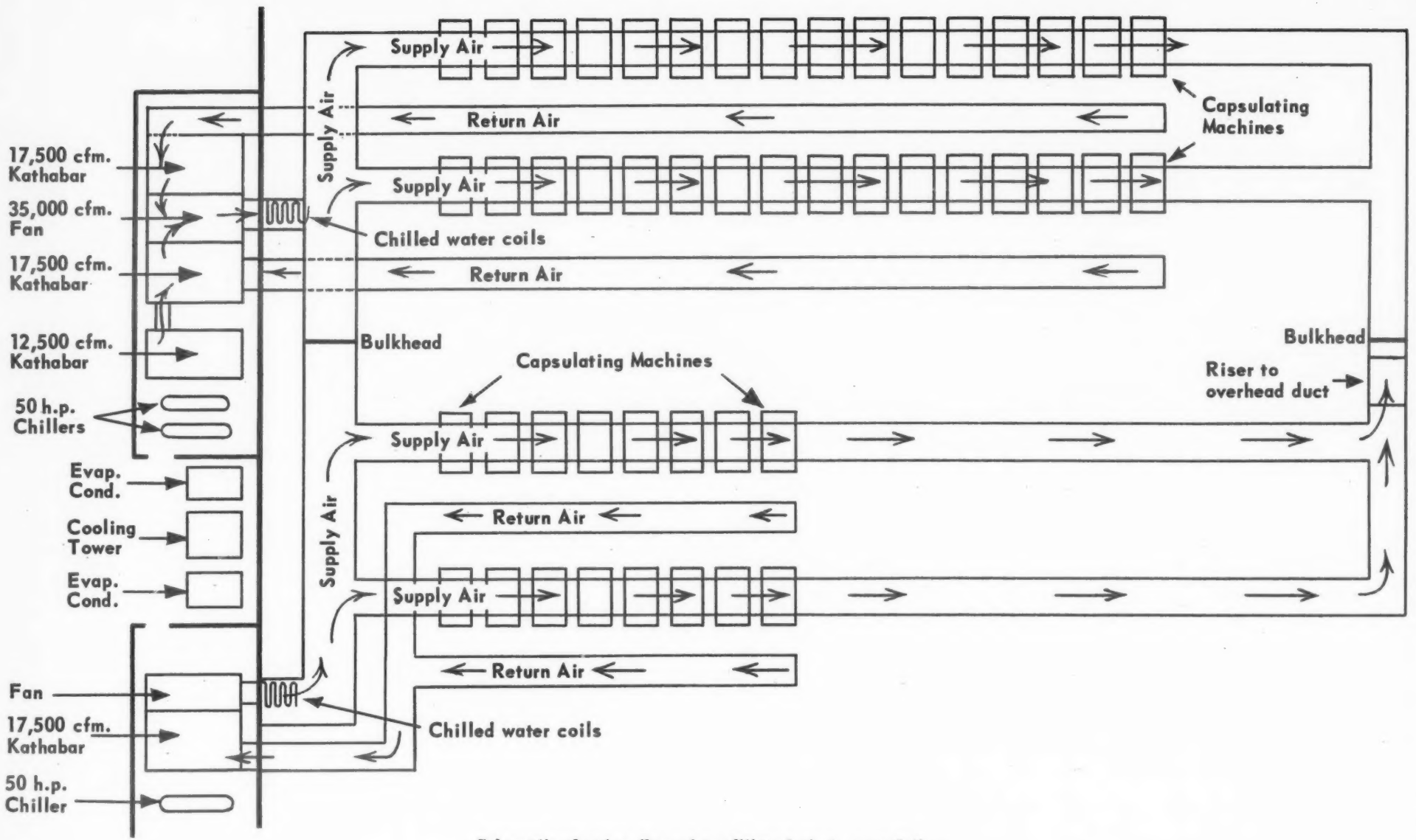
Below, air from cooling system is fed to this battery of capsulating machines from under-floor ducts. Exhaust air from machines keeps rooms cool during summer and maintains positive pressure in work area.



Schematic showing flow of conditioned air to capsulating machines, capsule drum dryers and to work area for space conditioning and pressure maintenance.

(Continued from page 39)

a 5 ft. dia. plenum to two 4 ft. round galvanized branch ducts. The two plenums are actually connected, but in current use they are separated by a bulkhead.

The branch ducts run in parallel straight lines the length of the capsulating room directly beneath the rows of capsulating machines. About 700 cfm of air feeds from the duct up through an opening beneath each machine.

Two hundred cfm blows onto each side of the revolving drum and the rest escapes through adjustable louvers in the machine cabinet into the room. Air flowing over the drum also dissipates around the edges of the drum into the room.

Two of the branch ducts handle rows of 16 machines each. The other two supply eight machines each. Excess air in the latter ducts feeds into a riser at the end of the room and then into an overhead duct where it is distributed into the room.

This air not only provides comfort cooling for employes, but also maintains a slight positive pressure on the room, protecting it against infiltration of airborne dust and dirt particles.

Air for Drying Machines

Just a few feet from the capsulating machines stand the drying machines. A series of six blowers on a single shaft in the base of each drying machine pick up 700 cfm of 72 F room air and drive it up over heating lamps and then through the revolving wire squirrel cage dryers.

A seventh blower on the same shaft then drives this air, now at about 80 F through a short underfloor duct to the drying tunnel. As it enters the tunnel, the air is filtered through a throwaway filter.

To the 700 cfm from the drying machine, 300 additional cfm is picked up from the room. An overhead recirculating blower moves this air continuously over the trays of drying capsules.

The air, now raised to about 82 F and about 30 percent relative humidity, is drawn off through a return air duct passing along the top of the drying tunnels. Along with room air picked up through grilles in the duct, this air is returned to the humidity control equipment. There it is chilled and dehumidified for another round.

Thus in a single cycle, the air serves three manufacturing processes and provides comfortable working conditions for employes.

A portion of this air is also supplied to an adjacent 60 by 120 ft. medical preparation room. It is here that ingredients for capsules are stored and mixed. This room uses all recirculated air and is equipped with its own humidity control unit to reduce relative humidity to 22 percent.

The separate chilled water system is installed at the front of the plant. Four 40 hp. chillers cool and circulate some 2,000 gals. of 42 F water through the plant for various cooling purposes.

This system employs a 600 gal. storage tank as a reservoir to keep the water pump from being starved. Water is pumped from the tank through the chillers and into the chilled water lines.

A temperature control beyond the last machine operates switches that kick compressors on and off to keep water temperature within 2 F of the required 42 F.

During summer two additional standby 50 hp compressors operate constantly to handle the increased heat load. The 40 hp compressors are started up as needed to hold the required water temperature.

Because of the large size of this system (260 tons), condenser water is cooled in a 250,000 gal. spray pond that decorates the front of the company property, rather than by a cooling tower.

Air Filtration Important

Along with temperature and humidity control, filtration is also an important aspect of air treatment. Obviously, dust and foreign particles cannot be permitted to get into the product or on the moist capsules.

Make-up air goes through an oil bath filter before passing through the humidity control unit where it is further washed by the lithium chloride solution.

Recirculated air passes through throwaway filters on leaving the humidity control units. Later, as it goes into the drying tunnels, the air is filtered a third time.

To further reduce dust in the air, the floor of the capsulating room is tiled.

Thus, with the lithium chloride system to control humidity, the chilled water system to control temperature, and three-stage filtration to control dirt, Scherer is able to maintain accurately controlled clean room conditions suitable for the manufacture of pharmaceutical products. ▲▲

EQUIPMENT CREDITS

Compressors: *Westinghouse Electric Corp., Trane Co.*
Chillers: *Westinghouse Electric Corp.*
Humidity conditioning units: *Surface Combustion Corp.*
Evaporative condensers and cooling tower: *Acme Industries, Inc.*
Fans and blowers: *Clarage Fan Co.*
Regulators: *Powers Regulator Co.*
Switches: *Mercoid Co.*
Throwaway filters: *Pittsburgh Plate Glass Co.*
Oil filter: *Continental Air Filters, Inc.*
Expansion valves: *Sporlan Valve Co.*
Recirculating pump: *Carver Pump Co.*
Water circulating pumps: *Allis-Chalmers Co.*

Questions & ANSWERS

Question:

The U.S. Atomic Energy Commission has, I understand, issued a revised series of values for levels of radioactivity in air. What are these values, what do they mean, and how will they affect industrial and medical users of radioisotopes?

CLH, N.Y.

Answer:

On May 4, 1959, the United States Atomic Energy Commission informed their AEC licensees of their proposed amendment to 10 CFR Part 20 "Standards for Protection against Radiation." This amendment gives new values for maximum permissible concentrations of radioisotopes in air and water.

The principal difference between the values set forth in the proposed new tables and the regulations of January, 1957, are a reduction to ⅓ of the permissible concentrations of those radioisotopes having their principal effect upon the gonads or the whole body (i.e., those as to which the "whole body" or gonads are considered to be the critical organ) and the lowering of others to control the exposure in the gastro-intestinal tract to 0.3 rem/week.*

Revised MPD Tables

The proposed amendment includes a comprehensive revision of tables of radioactive materials for their permissible concentrations in air and water above natural background. These new values are taken from the National Committee on Radiation Protection recommendations as given in the new National Bureau of Standards Handbook 69. Values are specified in these tables for exposures to persons in restricted areas and levels of radiation and concentration in unrestricted areas. The values given limit the radiation and concentrations of radioactive materials in unrestricted areas to extremely low levels.

New "Body Burden" Table

A new table entitled "Body Burden" not present in the previous standards has been added to the new proposed amendment. This table specifies that quantity of each of the listed radioisotopes which when present in the body is calculated to deliver a dose rate not more than 0.6 rem/week to thyroid or skin, 0.56 rem/week to bone, 0.1 rem/week to the gonads or total body, or 0.3 rem/week to other organs of the body.

The reduction in limits on permissible exposure to radiation which would be accomplished by adoption of these amendments should not be interpreted as an indication that exposures at limits previously permitted caused damage. The National Committee on Radiation Protection states regarding their recommendations:

"The changes in the accumulated MPD* are not the result of positive evidence of damage due to use of the earlier permissible dose levels, but rather are based on the desire to bring the MPD into the trend of scientific opinion;.....it is believed that the risk involved in delaying the activation of these recommendations is very small if not negligible.....it is recommended that a conversion period of not more than five years from (January, 1957) be adopted within which time all necessary modifications should be completed." ▲▲

REFERENCES:

1. Letter "Notice to Licensees of prepared amendment to 10 CFR 20 "Standard for Protection against Radiation" from H. L. Price, Director, Division of Licensing and Regulations. Atomic Energy Commission, Washington 25, D. C., May 4, 1959.
2. Proposed amendment to 10 CFR Part 20 "Standards of Protection against Radiation." Title 10 Atomic Energy. Chapter 1, Atomic Energy Commission.
3. Federal Register Vol. 22, Number 19, Washington, D. C., January 29, 1957, Title 10 Atomic Energy. Chapter 1, Atomic Energy Commission, Part 20 "Standards for Protection against Radiation."

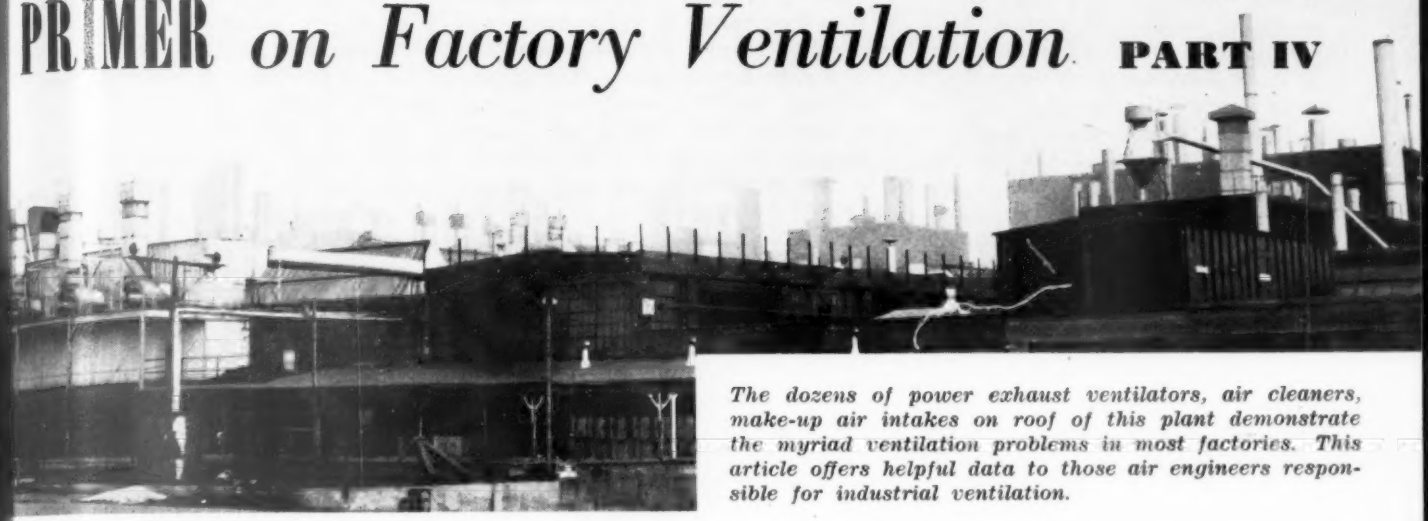
**Maximum Permissible Dose.*

Use Communications Center, page 33, for requesting more information about articles, advertised products, literature, and for comments about any of the editorial material in this issue of AIR ENGINEERING.

If you wish to contact manufacturers directly, street addresses are given. But please mention you saw it in AIR ENGINEERING.

"Sure, we do ventilating. Who do you want ventilated?"

PRIMER *on Factory Ventilation* PART IV



The dozens of power exhaust ventilators, air cleaners, make-up air intakes on roof of this plant demonstrate the myriad ventilation problems in most factories. This article offers helpful data to those air engineers responsible for industrial ventilation.

Now is the time to get ready for the heating season. Here is helpful data on which of the three basic make-up air systems to use, factors influencing sizing of make-up air units, types of equipment, temperature controls, filtering, air distribution, system numbering and cost factors involved.

IN THIS LAST of a four part series on factory ventilation, we will discuss air distribution methods, outlet velocities, make-up air identification systems and cost analysis of various systems.

A type of outlet which has been widely accepted in foundries is the continuous slot shown in Fig. 20. This design especially suits pouring and similar operations where personnel must move in a straight line such as along a conveyor. Although not readily apparent, this type of outlet is very flexible in that sections of the slot can be covered over to alter distribution or velocity.

The flanges at both sides of the slot make possible the installation of clips of various lengths which can be easily moved or entirely removed to suit requirements. In order that all the air will not discharge at the extreme ends of the slot the header or plenum above the slot must be tapered as shown.

Outlet velocity has been an item of conjecture perhaps since it is influenced to such a great extent by the nature of the operation, the area, and the type of activity. A figure often suggested is 100 fpm for every foot of distance from the outlet. This, however, is very low for foundry work since velocities are often in the neighborhood of 2,500 to 3,000 fpm.

A type of outlet which should also be briefly mentioned since it is certainly related to make-up air is the door blanket (Fig. 21). This is also a slot arrangement either across the top of the door opening or down both sides depending on door arrangement and proportions. An extremely high opening is best covered from the sides while a door that is twice as wide as it is high is, of course, best blanketed from the top. Slot velocities should be sufficient to provide 400 fpm at the floor for vertical discharge or 200 fpm at the center for side outlets. Discharge temperatures of 125 F can be safely used.

Outlet Location

To provide quick reference and identification of supply systems and heaters, all units should be numbered according to location, type of heat, whether supply or recirculating and number of unit. The following is a typical example:

4CL — GS — 2

The 4CL means the system is located in #4 Cleaning Dep't.

The GS indicates a gas fired supply or make-up air unit.

The 2 denotes the number of the unit within the department.

This type of unit designation provides complete information, and aids the Maintenance Department in their selection of personnel to

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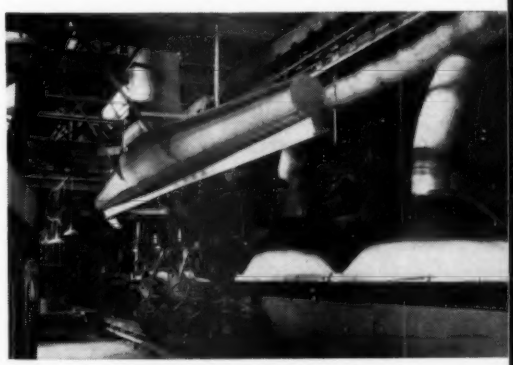
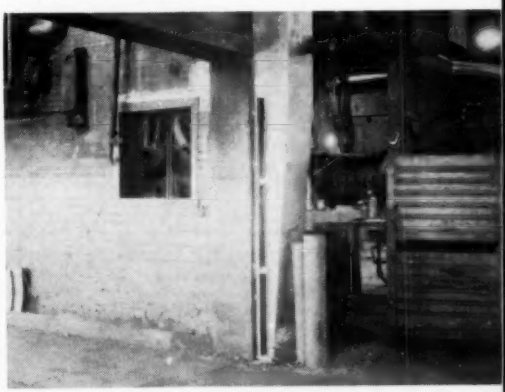


Fig. 20: *Continuous slot outlet is well suited to pouring, or where personnel must move in straight assembly line.*

Fig. 21: *Below, is a door blanket outlet consisting of a slot arrangement either across top of door or down both sides.*



(Continued from preceding page)
send out in case of service calls.

In case of smaller plants it may be more convenient to use department numbers or building numbers to indicate system location. Whatever variation is used, the designation should describe the equipment as completely as possible. The complete designation should be stenciled on the heater within plain view of the ground floor.

Such a system of identification will save much time and confusion in correspondence, records, and service requests relative to the make-up air units.

No discussion of make-up air systems would be complete without a study of the cost of various systems. Table II is a tabulation of actual installation costs in a large foundry, per cfm capacity. It is obvious, of course, that this figure varies not only according to the equipment included in the system, but also according to conditions existing at the time the installation was made. It is therefore impossible to provide any one representative figure as a basis for estimating cost; however, the figures shown in the tabulation could possibly be used as a guide.

The importance of make-up air cannot be overlooked in the design of industrial exhaust systems for unless make-up air is available even the best designed exhaust equipment cannot function. From the idealistic approach, make-up air supply amounting to approximately 120 percent of exhaust capacity would be desirable.

There is available a wide variety of make-up air heating equipment. The type to be used as well as fuel and arrangement will be determined by local conditions. Because most industrial plants have steam generating equipment to supply process steam, etc., it is usually economical to use steam for heating purposes to utilize the full capacity of the generating plant.

Once this capacity is fully utilized, other types of heating equipment must usually be used. Barring the possibility of supply interruption, gas is clean burning, efficient, and gas burning equipment is easily maintained. Where possibility of interruption exists, combination oil-gas heaters can be installed; however, line burners cannot be used under these conditions.

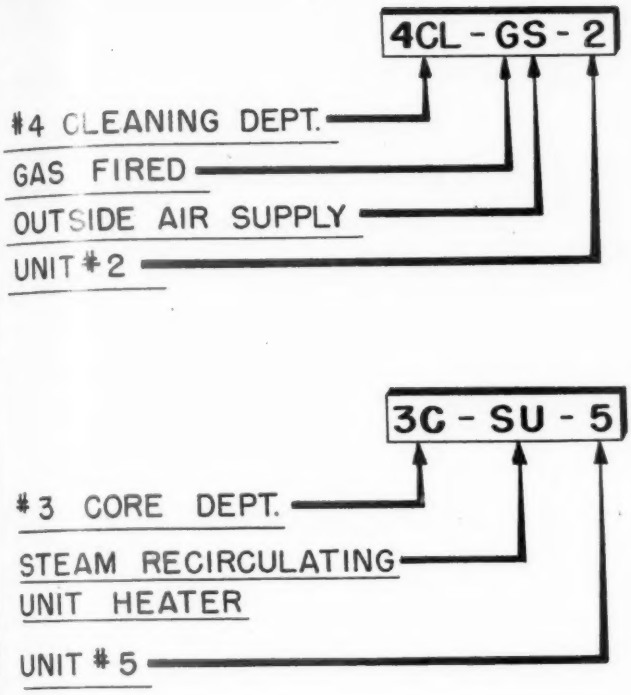
Where continuous gas supply is a certainty and rates are competitive, the line burner should be given consideration. When properly adjusted and used for make-up air only (not recirculated), these heaters are entirely safe.

Regardless of the type of heater being used, automatic temperature control equipment should be used. This equipment will quickly pay for itself in fuel savings alone. In make-up air applications the

TABLE II

DATE	SYSTEM	EQUIPMENT	BTUx10^6	CFMx10^3	Cost/CFM	REMARKS
1954	EAST STREET	GAS LINE BURNER	2.75	30	$.34	2 UNITS - INSTALLED ON STRAIGHT TIME - MINIMUM DISTRIBUTING DUCTWORK
1955	#2 CLEANING ROOM	GAS LINE BURNER	3.50	42.9	.47	INSTALLED ON OVERTIME
1955	EAST STREET	GAS LINE BURNER	3.00	33	.34	INSTALLED ON STRAIGHT TIME.
1955	ENGINEERING OFFICE	STEAM COIL. ELECTROSTATIC FILTER & WASHABLE FILTER		4.7	1.38	INSTALLED ON STRAIGHT TIME
1955	#4 CLEANING ROOM	GAS LINE BURNER	1.75	20	.35	2 UNITS - INSTALLED ON STRAIGHT. TIME
1955	#2 CORE ROOM	GAS LINE BURNER	5.00	50.3	.35	2 UNITS - COMBINATION STRAIGHT & OVERTIME
1955	#3 & 4 CONV. POURING LOOP - FRESH AIR	SPRAY WASHER		34.2	.27	COMBINATION STRAIGHT & OVERTIME
1955	#3 CUPOLA BASEMENT FRESH AIR	GAS LINE BURNER	.75	9	.52	
1955	#17 & 18 CONV.-SHAKEOUT FRESH AIR	CAPILLARY AIR WASHER		30	.53	
1955	#13 & 14 CONV.- FRESH AIR	GAS LINE BURNER SPRAY WASHER	4.00	41	.52	
1955	#1 CORE ROOM - FRESH AIR	GAS LINE BURNER - 2 FANS	5.00	52	.42	COMBINATION STRAIGHT & OVERTIME
1956	#1 CORE ROOM - FRESH AIR	STEAM COILS		26.5	.63	2 UNITS
1956	#9,10 & 11 CONV. POURING LOOP FRESH AIR	SPRAY WASHER		33.8	.41	
1956	LOCKER ROOM SUPPLY	STEAM HEAT, DAMPERS, SPRAY WASHER, FILTER & DAMPERED SYSTEM		44.0	1.07	INSTALLED ON STRAIGHT TIME
1956	#1 CLEANING ROOM	GAS LINE BURNER SPRAY WASHER		33.8		

This table is a tabulation of actual installation costs of make-up air systems in a large foundry. Note how costs vary, depending on type of system and date equipment was installed.



Left, this chart shows a ready reference identification system for make-up air units. Chart is self-explanatory.

duct thermostat has been most satisfactory. It is not influenced by local conditions, cannot be as easily tampered with, is not subject to damage by production operations, and provides constant temperature air to the work area.

No item is as important to the make-up air system as the outlet system. Unless outlets are located and designed so they continuously deliver their full design volume, the system of which they are a component part cannot supply the volume of make-up air needed, resulting in wasted equipment and power.

So that make-up air supply outlets will remain open under all conditions, thereby assuring a continuous supply, outlet equipment should be fully adjustable to meet all requirements but cannot be closed off. Numerous diffusers and grilles are commercially available that meet these requirements in varying degrees.

Very often, however, equipment must be improvised to give desired results. Whatever device is used it is often desirable to have a variation in outlet velocities without jeopardizing system volume.

This can be simply accomplished by installing additional outlets or pressure reliefs at various points in the system. These outlets are set to provide outlet capacity to compensate for reduction in volume at the grilles or diffusers as necessary to provide the desired velocity.

An important factor in continued and satisfactory operation of make-up air units is a program of education for both maintenance personnel who must keep the equipment in operation, and production personnel who must live with the system. Certainly maintenance personnel completely familiar with the equipment and its purpose will provide better care and will make special efforts to keep the equipment in operation.

Educational Program

Likewise production people who fully realize the purpose and benefits of make-up air will also make every effort to insure operation of the supply systems. In the final analysis these are the people for whose comfort and health industrial ventilation systems are engineered and installed.

In order that the equipment is properly operated they too must be taught that "effective industrial ventilation is the use of air to remove unwanted materials *and the replacement of that air* with relatively clean fresh air to provide a healthful comfortable climate for the worker." ▲▲

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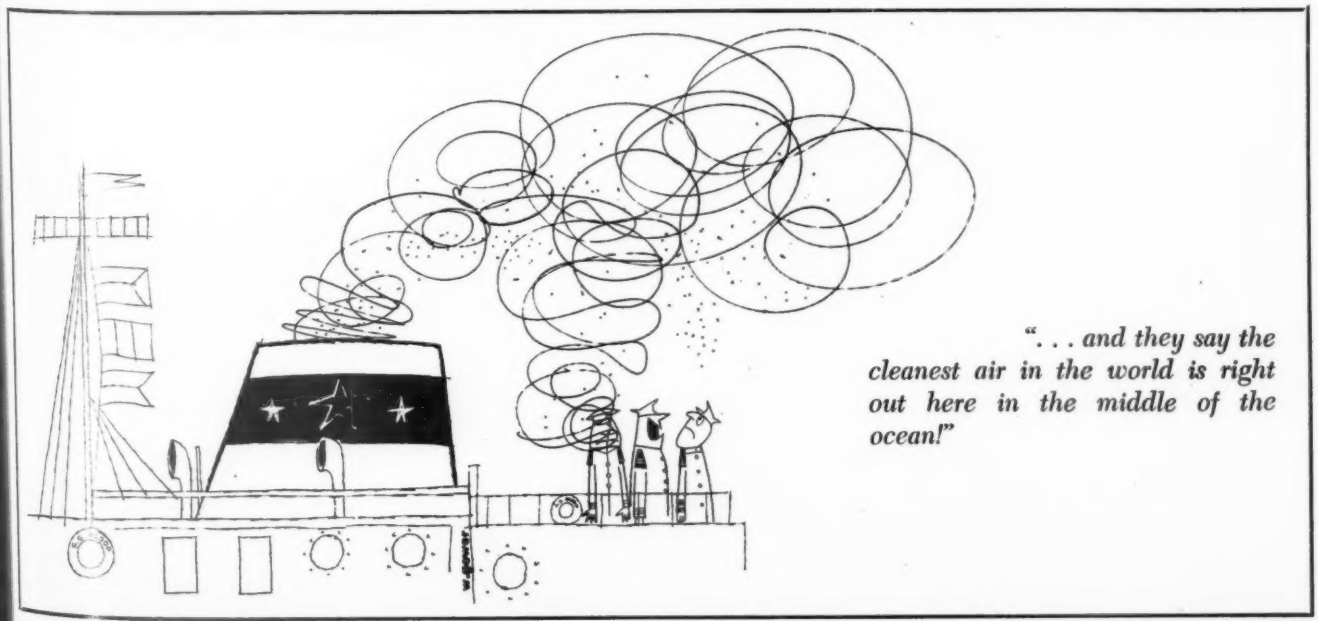
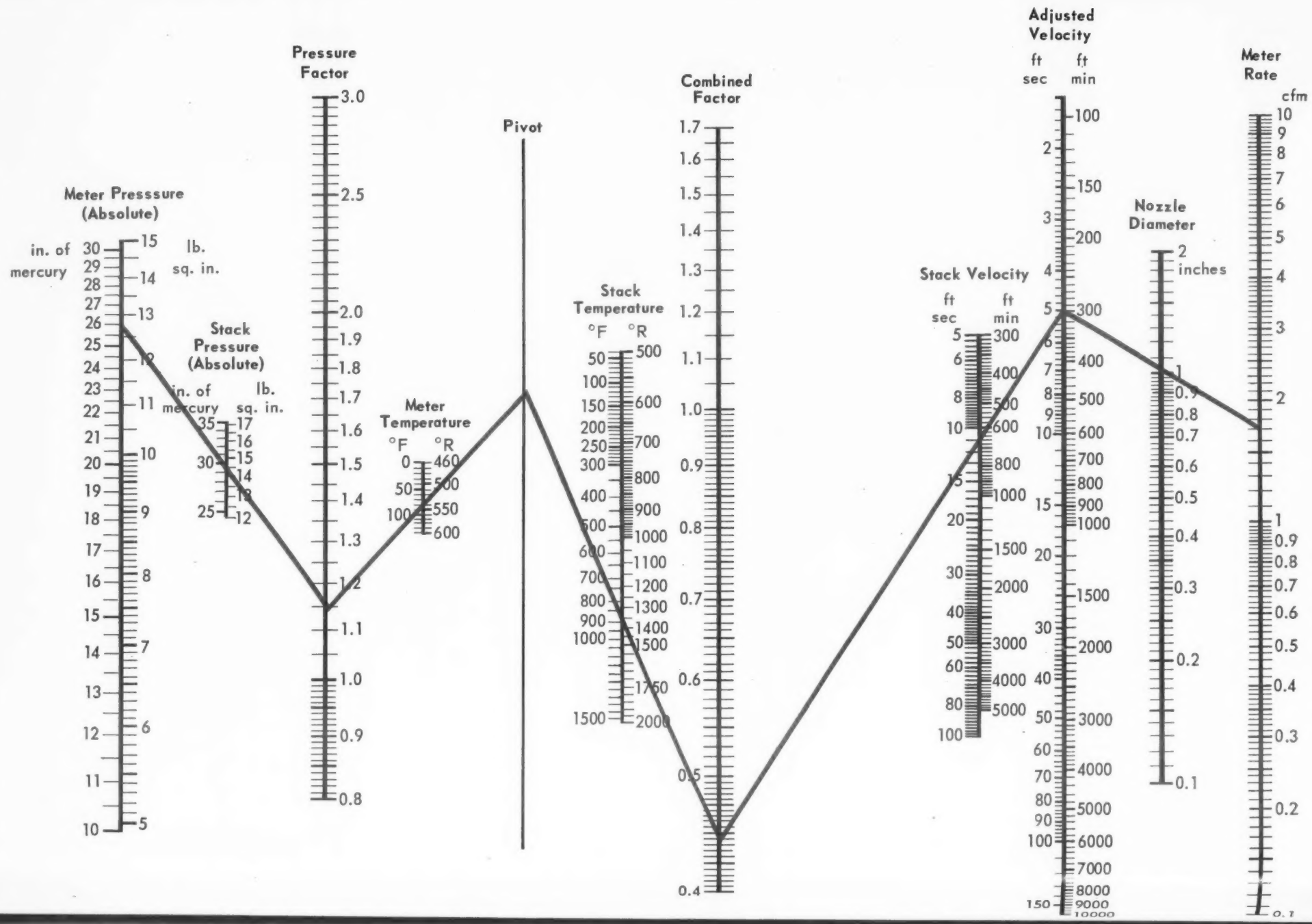


". . . and they say the cleanest air in the world is right out here in the middle of the ocean!"



Short Cut to Stack Sampling

Short Cut to Stack Sampling

by Marvin Greene
Chemical Engineer

Sampling to measure the emission rate of fly ash, dust and similar particulates from stacks involves the insertion of a nozzle into the stack through which the sample is drawn. The nozzle is attached to a Pitot tube which leads into a device such as an impinger or filter that removes the suspensoid from the gas. Additional basic units in the sampling apparatus include a condenser to cool the gas and retain any condensate, a meter to measure the rate of gas flow, and a pump to provide suction for the system.

Under isokinetic sampling conditions, the gas is drawn through the nozzle at the same velocity as that in the stack. In this way untoward velocity effects on different size particles are avoided. The nomograph provides a simplified means for determining nozzle size under varying conditions and for determining adjustable parameters for a given nozzle size. For initial calculations before sampling is started, it is necessary to neglect water condensate as a part of the flow that does not pass through the meter.

Temperature and pressure of the gas in the nozzle are essentially equal to stack temperature and pressure, based on the assumption that pressure drop and change in temperature in the short nozzle are negligible. In the great majority of stacks, the pressure varies at most only a few inches from barometric pressure. Because one inch of water is equivalent to only 0.0736 in. Hg, it is sufficiently accurate to equate stack pressure to the barometric pressure.

The basic relationship in isokinetic sampling is:

$V_s = V_n$

V_s = velocity of gas in stack, feet per second
V_n = velocity of gas in nozzle, feet per second

The volume rate of flow through the nozzle is proportional to the velocity and the square of the nozzle diameter.

$$R_n = V_n A_n \times \frac{60 \text{ sec}}{\text{min}} \times \frac{\text{sq. ft.}}{144 \text{ sq. in.}}$$

R_n = nozzle flow rate, cubic feet per minute
A_n = area of nozzle, square inches
d_n = diameter of nozzle, inches

$$A_n = \frac{\pi}{4} d_n^2$$

$$R_n = \frac{60 \times \pi}{4 \times 144} V_n d_n^2$$

$$R_n = 0.327\ V_n d_n^2$$

Conditions at the nozzle are equated to those at the meter through the Perfect Gas Law.

$$\frac{P_n R_n}{T_n} = \frac{(P_b - P_m) R_m}{T_m}$$

$$R_m = R_n \times \frac{T_m}{T_n} \times \frac{P_n}{P_b - P_m}$$

P_n = static pressure at nozzle, inches of mercury
P_m = suction at meter, incheas of mercury
P_b = barometric pressure, inches of mercury
T_n = temperature at nozzle, 460 + °F
T_m = temperature at meter, 460 + °F
R_m = meter flow rate, cubic feet per minute

$$R_m = R_n \times \frac{T_m}{T_s} \times \frac{P_s}{P_b - P_m}$$

P_s = static pressure in stack, inches of mercury
T_s = temperature in stack, 460 + °F

$$R_m = 0.327\ V_s d_n^2 \times \frac{T_m}{T_s} \times \frac{P_s}{P_b - P_m}$$

The first six scales of the nomograph provide for the adjustment of one set of conditions of temperature and pressure to a second set by means of the Perfect Gas Law, where the molecular weight of the gas is not known. The pressure factor is obtained first, with the combined temperature-pressure factor determined by use of the scales for meter and stack temperatures. Stack velocity is then adjusted to the theoretical velocity under conditions of meter temperature and pressure. The adjusted velocity is used to determine nozzle diameter or meter rate, whichever is sought.

EXAMPLE: Velocity of gases in a stack averages 660 fpm at a temperature of 900 F and 2 in. w.g. (essentially barometric pressure). It is assumed that the suction developed at the meter over the course of collecting the sample will average 4.0 in. Hg. at a temperature of 70 F. What size nozzle is necessary for a desired meter rate of 1.7 cfm? Barometric pressure is 30.0 in. Hg.

Step 1. Draw a straight line from 26.0 on the meter pressure scale (30.0 — 4.0) through 30.0 on the stack pressure scale and continue to pressure factor scale, where intercept reads 1.15.

Step 2. Draw a second straight line from the intercept on the pressure factor scale through 70 F on the meter temperature scale and continue to the pivot.

Step 3. From the pivot intercept draw a straight line through 900 F on the stack temperature scale and connect with the combined factor scale. The intercept reads 0.450.

Step 4. Connect the intercept on the combined factor scale with 660 fpm on the stack velocity scale and continue to the adjusted velocity scale, where the intercept is 297 fpm.

Step 5. Draw a straight line from the intercept on the adjusted velocity scale to 1.7 on the meter rate scale. Where the line intersects the nozzle diameter scale, read the answer 1.03 in.

New PRODUCTS

Adjustable Chimney Cap

Purpose: Protect vent system from entry of snow, rain, debris, birds.

Features: Adjustable wide range collar reduces inventories since four Versacap models do work of 12 standard chimney caps. No down draft. Positive draft is created by Venturi action under any wind direction or speed. Available in corrosion resistant aluminum.

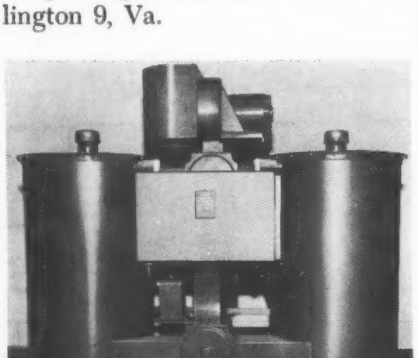
Source: Leslie Welding Co., Inc., Dept. AE, 2943 W. Carroll Ave., Chicago 12, Ill.

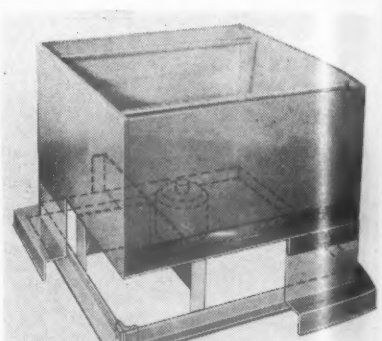
Industrial Dehumidifier

Purpose: Dry air in processing applications, humidity control in unheated spaces, low temperature installations, and with refrigeration equipment to control humidity without reheat.

Features: Una-Dyn model A75 handles up to 700 cfm and can remove 300 lbs of water in 24 hours. Complete self-contained for "plug-in" installation.

Source: Universal Dynamics Corp., Dept. AE, Box 9814A, Arlington 9, Va.





Power Roof Ventilator

Purpose: For industrial service.

Features: Structa-Lung has a powerful suction that sweeps up heat, moisture, dust, and fumes and exhausts them in a jet that shoots up 20 to 30 ft. above the ventilator.

When fan is off, automatic dampers in top portion of ventilator close and form leak proof seal. Fan assembly is supported by framework of structural angles and heavy plate.

Capacities range from 8 to 80,000 cfm.

Source: Structa-Lung Co., Dept. AE, 36407 Euclid Ave., Willoughby, Ohio.

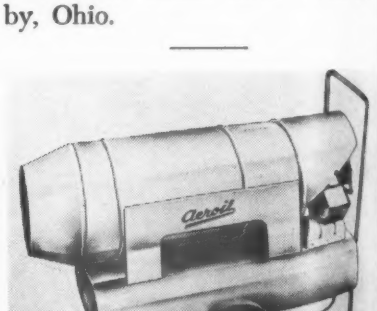
Solvent Recovery Fan

Purpose: Solvent recovery in the petro-chemical industry.

Features: Designed and built to minimize possibility of explosion when handling highly volatile solvent vapors. It is basically an American Blower type HE fan with 50 in. radial blade wheel fabricated of aluminum and cast manganese-bronze spider.

Rated at 200 bhp, it delivers 19,000 cfm at 1780 rpm, 100 F and 42.5 in. wg static pressure.

Source: American-Standard Industrial Div., Dept. AE, Detroit.



Space Heaters

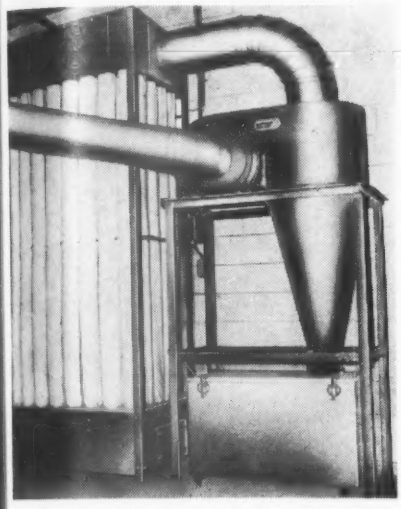
Purpose: Spot heating.

Features: Portable, mounted on rubber tired wheels. Made in three oil-fired sizes: 125,000, 250,000, and 500,000 Btu. Have stainless steel combustion chambers with gun type atomizing pressure burners. Continuous ignition supplied by 10,000 v transformer. Fuel tanks are integral part of heaters.

Source: Aeroil Products Co., Inc., Dept. AE, 69 Wesley St., South Hackensack, N. J.

Cloth Tube Auxiliary Filter

Purpose: For operations where a high volume of fine dust or fine dust mixed with heavy dust is encountered. For use with 3,000 or smaller series Dustkops.



Features: Its 40 cloth tubes are made of flame resistant material and sealed top and bottom by molded rubber grommet to reduce wear and hold tubes tightly in place.

F. T. 40 is equipped with manual shaking device that drops dust into storage bin at bottom. Inlet flange at filter top can be at sides or ends.

Source: Aget Mfg. Co., Dept. AE, Adrian, Mich.

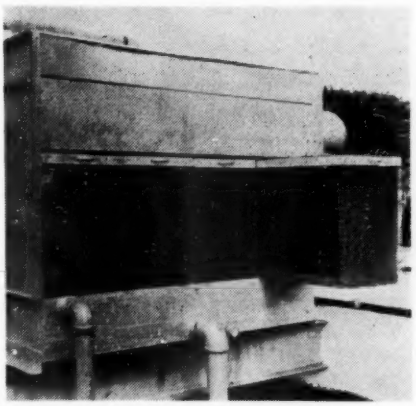
Packaged Solvent Recovery Units

Purpose: To recover relatively low concentrations of solvents in air.

Features: Resorbers Type 35 and 36 will remove up to 85-95 percent of solvent or contaminants from air stream and recover it for reuse. Efficiency depends on size of unit, temperature of gas stream, and chemical nature of solvent to be recovered or removed.

Made in steel plus stainless for highly corrosive operations. Six units available in both series ranging in capacity from 400 to 4400 cfm.

Source: Barnebey-Cheney Co., Dept. AE, Cassady & Eighth Ave., Columbus 19, Ohio.



Water Cooling Towers

Purpose: Cooling water.

Features: 4-B Series is made in 16 sizes from 5 to 360 tons. Use squirrel cage blowers rather than propeller fans for quiet operation. Low silhouette as maximum heights range from 5 ft 5 in. to 7 ft 8 in. exclusive of foundation beams.

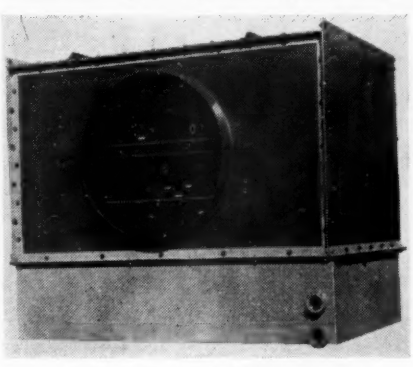
Multiple blowers used on larger towers. Filtered air inlets available for use in high contamination areas.

Source: Binks Mfg. Co., Dept. AE, 3114 Carroll Ave., Chicago 12.

Air Washer

Purpose: Removal of water-soluble acids and alkalies.

Features: Entirely fabricated of PVC for less resistance to air flow. Cleans 96 to 99 percent of contaminants passing through if they



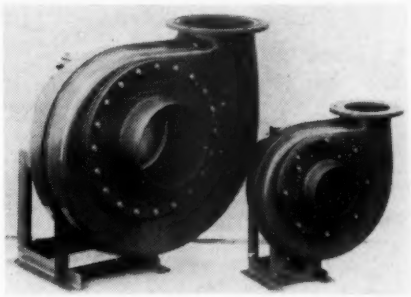
are instantly soluble in water. About one-sixth the weight of steel. PVC has practically no water absorption. Use approximately 1 gpm per 1000 ft of air handled.

Source: Industrial Plastic Fabricators, Inc., Dept. AE, Endicott St., Norwood, Mass.

PVC Blower Series

Purpose: For suction, blowing, ventilating, and exhausting wherever resistance to acids and corrosive gases is a factor.

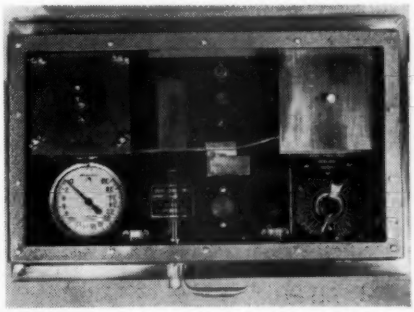
Features: Made in 16 sizes from 5 to 28 in. suction and discharge outlets. Aero-dynamically perfect injection molded fan wheels made



of low pressure polyethylene. Blower cases made of pressed PVC and cover plates fastened with stainless steel screws and nuts.

All blowers equipped with iron pedestals and motors. May be mounted in any of eight positions.

Source: Milo Mfg. Co., Dept. AE, 358 North Broad St., Elizabeth, N. J.



Hi-Flow Tape Sampler

Purpose: Sampling atmospheric particulate matter automatically.

Features: Provides large mass of particulates by means of high flow rate per unit area developed by heavy duty carbon vane rotary pump. Microweb filter media can be used for either destructive or non-destructive testing.

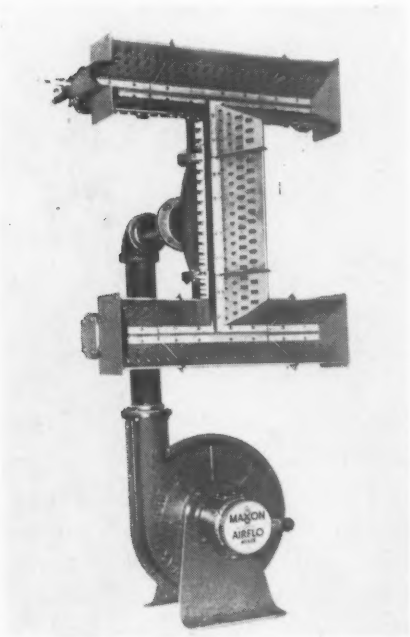
Continuous operating sampler can take 60 samples at intervals of from one to 30 hours unattended.

Source: Research Appliance Co., Dept. AE, P. O. Box 307, Allison Park, Pa.

(Please turn to following page)

New PRODUCTS

(Continued from preceding page)



Gas Burner System

Purpose: Heating make-up air in industrial plants, heating ovens, kilns, and dryers.

Features: Airflo gas burner system has 25 to 1 throttling range. May be used on either recirculating or single-flow systems. Stainless steel mixing plates mount directly in duct carrying stream of air to be heated. Mixer unit mounted outside duct. Single lever controls firing rate.

Source: Maxon Premix Burner Co., Dept. AE, 201 East 18th St., Muncie, Ind.

Toxic Gas Detector Kits

Purpose: To permit industrial hygienist, safety engineer, or chemist to determine if gas concentrations are at, below, or above maximum allowable concentrations.

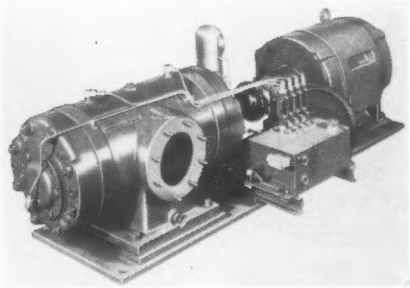
Features: Model NF is used with gases and vapors which can pass directly through detector tubes. Model F is used for gases or vapors which must be initially passed through a pyrolysis train prior to admittance to the detector tubes. NOT designed for determining exact parts per million. Instruction manual furnished with each kit.

Source: Davis Emergency Equipment Co., Inc., Dept. AE, 45 Halleck St., Newark 4, N. J.

Rotary Booster Compressor

Purpose: For low temperature refrigeration and air conditioning applications, multi-stage systems.

Features: VRB series available for use with ammonia, Refrigerant-12, Refrigerant-22 in capacities from four to 400 tons. VRB is of



sliding vane type, internally lubricated by mechanically driven force-feed lubricator.

Source: Vilter Mfg. Co., Dept. AE, 2217 S. First St., Milwaukee 7.

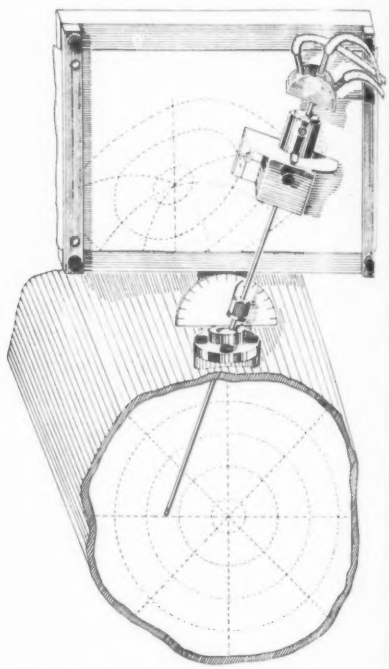
Portable Hydrocarbon Detector

Purpose: For instantaneous measurement of carbon impurities in air, use as atmospheric monitor of air pollution or lower explosive limits.

Features: P-E Model 213 has sensitivity better than 0.1 ppm. Range may be adjusted from 0 to 1 ppm up to 0 to 10 percent. Response time is less than two seconds.

Heart of instrument is flame ionization detector. Housed in aluminum enclosure 18 by 13 by 8 in. Weighs 47 lbs.

Source: Perkin-Elmer Corp., Dept. AE, Norwalk, Conn.



Area Traverse Unit

Purpose: Measure velocity, pressure, direction, and temperature at any point on a given cross section of a flow duct or other piece of fluid flow machinery. Measure efficiency of turbines, blowers, compressors.

Features: Manually operated or remote controlled types. Manual type uses single access hole at cross section, ball and socket pressure joint, and a plotting board mounted perpendicular to flow direction and parallel to cross section to be measured.

Probe with pressure, temperature sensing element is moved in cross section as outer end is positioned on plotting board.

Source: United Sensor & Control Corp., Dept. AE, Box 127, Glastonbury, Conn.

Hospital Air Conditioning

(Continued from page 20)

Effectiveness of germicidal lamps in air duct work has been established.[7] The use of submerged germicidal lamps has found application in many water treatment plants. These ultraviolet lamps are effective only if the media itself does not interfere with the transmission. By filtration of the recirculated air washer solution we accomplish an optimum condition for the submerged germicidal lamps and approach an infinite contact time so far as the captured microorganisms are concerned.

There are a number of materials non-volatile in character that might prove effective bactericidal agents when added in controlled amounts to the washer sump. Further investigation of some of these materials in this application should prove fruitful.

In summary, we have described a unique air conditioning system for hospitals. Its main purpose is to provide economical central station temperature and humidity control for a variety of hospital functions. It also affords positive control of air contamination so necessary in maintaining hospital areas sterile.

Air Sanitation Achieved

The key to the Multi Dew Point System is provision for an effective means of continuous collection and removal of airborne microorganisms from the hospital environment while maintaining at all times newly wetted equipment surfaces in contact with moving air streams.

Because the refrigeration coil is handling already saturated air, its surface is wet and residue is continually collected and drained from the system. In this way the problem of microorganisms passing through the equipment or generated within the equipment is minimized. All air is thoroughly washed before entering conditioned space. This minimizes exterior contamination of outside air and cross contamination where return air is used.

Permits Use of Recirculated Air

This system will permit future use of recirculated air for hospital areas now employing 100 percent outside air once proper control levels in these areas are determined. Static pressure differences in air supply and return are used to help determine hospital air patterns. However, at least for areas employing recirculated air, all vitiated air has an opportunity of returning through some alternate route to a cleansing air wash prior to being supplied again.

While providing the preceding additional benefits, this system can be assembled at a cost no greater than for a conventional air conditioner employing an electrostatic prefilter and a multiplicity of zoned duct sprays and controls. It should be emphasized that this system can truly be effective only if hospital procedures simultaneously focus on effective sterilization techniques throughout the institution.

We believe true air conditioning for hospitals should be capable of delivering air free of contamination in addition to relieving discomfort and nervous strain on the patient and hospital staff. ▲▲

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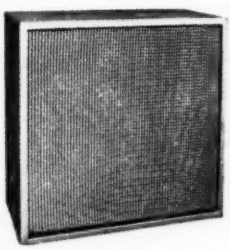
7. Nagy, R. G. Mouromseff, and Pixton, F. H. "Disinfecting Air with Sterilizing Lamps." *Heating, Piping, and Air Conditioning.* Vol. 26. 83. April, 1954.

COMPLETE FILTRATION FOR SUB MICRON PARTICLES



Flanders AIRPURE Absolute Filters

Airpure absolute Filters combine the greatest dust holding capacity with the lowest resistance factor.

- 15% more filter medium, catches more particles
- Filter medium has no binder to clog pores
- Filter medium has low initial P.D.

Rate it either way: 1000 CFM @ .75" W.G.
1300 CFM @ 1.00" W.G.

Many models available for a wide variety of applications.

FOREMOST PRODUCERS OF ABSOLUTE FILTERS FOR AEC INSTALLATIONS

AIRPURE Flanders Filters INC.

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Dust Control In The Copper Industry

DUST PRODUCING OPERATIONS in uranium, copper, and taconite industries are quite similar, according to David E. Bonn, supervising engineer, dust control products, American Air Filter Co.

In a talk given by Mr. Bonn to the Mines Accident Prevention Association of Ontario, he pointed out that a 300 ton per day uranium mill, exhausting about 42,000 cfm from transfer points, crusher, vibrating screen, roaster, and quenching operation, returns over 12,900 lbs per 24 hours of valuable fines to process. These collected fines were found to contain four to seven times more uranium than the average run of ore.

Some practical suggestions outlined for controlling dust at various operations included: when mined ore is dumped onto pan feeders or conveyor belts, best practice is to keep the hopper partially filled with material at all times.

If this is not practical, use flights to cascade material to hopper bottom to prevent the terrific surge of dust that is forced down the conveyor belt when large volumes of rock are dumped into hoppers with considerable free fall.

Vibrating screens should be used between crushing stages in copper and taconite mining, and screens should be enclosed and exhausted from the top to avoid pickup of material. A vibration band should be used between the hood duct work and the branch pipe to prevent vibration from being transmitted to the branch.

For good dust control in the metal mining industry, exhaust volume required is 700 to 800 cfm per foot of belt width.

To keep exhaust volumes at a minimum, distance ore falls should be kept as short as possible. When necessary to dump directly from conveyor to conveyor belt, the plenum should be large . . . four to six diameters, with exhaust hood long enough to allow the dusty air to be captured. Another good practice mentioned is the use of rubber sheeting at the hood discharge to prevent dusting out.

The rubber should not drag on the conveyed material but should be 2 in. above the highest point of the ore on the belt.

For easier maintenance, static tap holes should be drilled behind hoods, ahead of and behind fan and collector so that pressure readings taken with a manometer U-gauge can indicate extremes in system resistance caused by plugged ductwork or adverse collector performance.

PROFESSIONAL SERVICES

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RATES—Classified advertising is run in 6-point type (this size) under suitable headings. Minimum rate $5.00 for forty words or less. Extra words .15 each. Box addresses, with usual services, count as five words. Payment required with order. No agency commission, no checking copies. Closing date first of month preceding month of issue. No proofs will be submitted prior to running, but proof will be forwarded for record. No display advertising under classified headings. AIR ENGINEERING, 450 W. Fort Street, Detroit 26, Mich.

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AIR POLLUTION TECHNOLOGIST—desire graduate chemist or engineer with experience and training in air pollution or industrial hygiene investigations and control measures. Position requires statewide travel to assist develop and operate an expanding air pollution and industrial hygiene program. Salary dependent upon experience and education. H. G. Bourne, Jr., OHIO DEPARTMENT OF HEALTH, 306 State Departments Building, Columbus 15, Ohio.

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